The FOUNDRY

Volume 58
Number 7

Published
Semimonthly

CLEVELAND, OHIO, APRIL 1, 1930

Castings Steady the Nerves by Preventing Slams

SOON after the child starts toddling from one room to another, Mother usually takes particular pains to explain carefully that it is not best to slam doors. These steps are taken to prevent smashed fingers and also to lessen as much as possible the wear and tear on Mother's and Father's nerves. As the youngster grows up

Beauty and Utility Are Embodied in Door Stops Which Blend with Building Design

and approaches the play age, continual vigilance is necessary, for it is such a temptation to rush madly in and out of doors, allowing the screen door to slam, and thus causing the family and the neighbors much annoyance. In some instances the early training bears fruit, much to the benefit of all mankind. In other cases, well—somebody had an idea one day and developed a device to put to an end the slamming of doors. Since that time a big business has been developed in the manufacture of door checks. Of course, it must be admitted that other agencies, such as the wind, may have been contributing factors in the development and adoption of door checks. This equipment is the product of the foundry, since practically all of the parts are castings. In the early types, utility was the major factor affecting design, but in recent years, beauty has been combined with utility to produce a unit which blends nicely with the artistic trends in buildings in which the checks are installed.

Find Where Castings Can Be Sold

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PUBLISHED BY THE PENTON PUBLISHING CO., CLEVELAND, O.

BRANCH OFFICES

CHICAGO.....1347 Peoples Gas Bldg.
CINCINNATI.....209 Edwards Bldg.
NEW YORK.....2203-2206 No. 220 Broadway
PITTSBURGH.....2148-49 Oliver Bldg.
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Cable address, IROTRAPEN, London

SUBSCRIPTION

United States and Mexico.....$3.00 a year
Canada.....$4.00 a year
Great Britain and other Foreign Countries.....£1:0:0 a year
Single Copies.....25 cents

Copies published three months or more previous to date of current issue, 50 cents each

Member, Audit Bureau of Circulations, Associated Business Papers Inc., National Publishers' Association

The A. B. P. is a nonprofit organization whose members have pledged themselves to a working code of practice in which the interests of the men of American industry, trade and professions are placed first—a code demanding unbiased editorial pages, classified and verified subscribers, and honest advertising of dependable products

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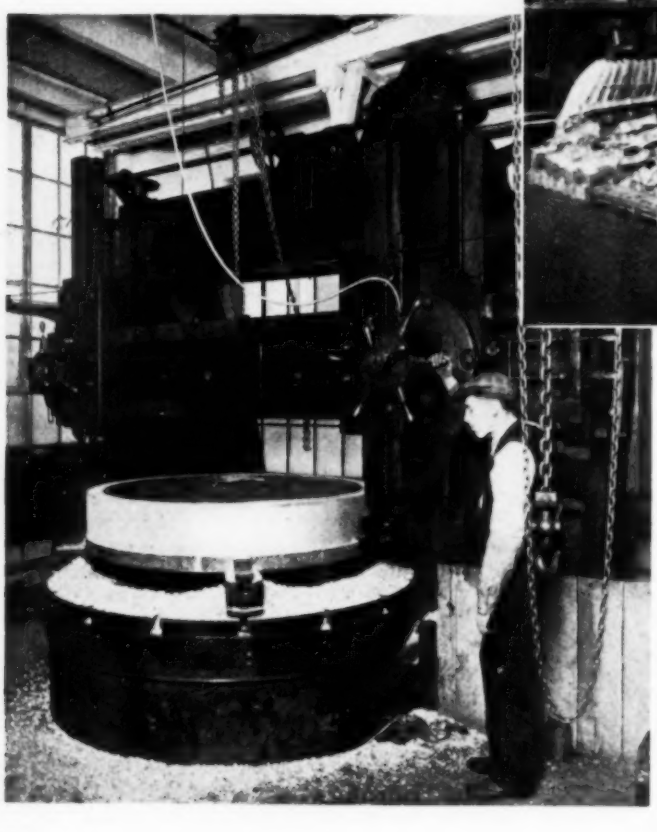
Patternmaking Requires

CO-OPERATION is one of the major factors contributing to the success of an industrial enterprise. Not only it is necessary between the management and the workmen throughout the plant but it also is essential between departments in the company. The latter is especially true with regard to the patternmaking and molding departments of a foundry. Sloppy or inefficient workmen may produce poor castings with good pattern equipment but it is impossible for the skilled molder to make good castings from an inferior pattern. Therefore, patterns exert no small influence on the production of a foundry and upon the profits of the foundryman.

Patterns are made available to the foundryman either by a department for that class of work within the shop making the castings or by commercial pattern shops. An interesting example of the latter type is the Motor Patterns Co., Cleveland, manufacturers of complete pattern equipment for all types of castings. That company makes wood and metal patterns of all descriptions and specializes in production pattern equipment. It has made patterns for foundries all over the United States and many foreign countries. It also has supplied complete pattern equipment to many foundries specializing in the production of stove, furnace, aeroplane and automobile castings.

Present members of the Motors Patterns Co. secured control on March 1, 1925. The personnel of the management includes J. S. Parker, general manager; H. R. Street, foundry consultant; R. A. Parker, in charge of mounting and rigging; A. F. Anderle, shop manager; J. P. Johnson, engineer and W. C. Mahon, in charge of sales. Those men are not only patternmakers but are experienced foundrymen. With this set up the organization has both the viewpoint of the foundryman, engineer and the patternmaker. This is a valuable asset to any patternshop.

In 1925 the wood shop, the metal pattern department and the foundry were confined to one building with 8000 square feet of floor space which gave an operating area for 60 men. The company now occupies a large "L" shaped building which has a total of 14,700 square feet of floor space with employment provisions for 150 men and in addition operates an experimental and engineering department separately housed.



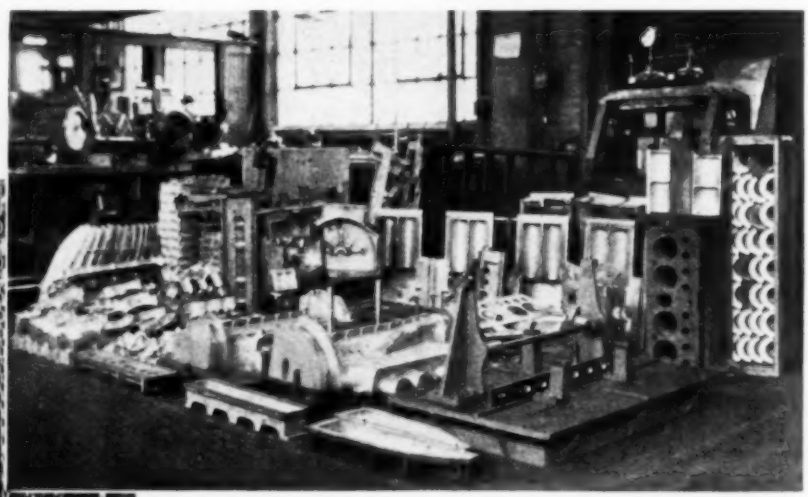


Fig. 1 (Left)—Large Machinery Is Required for Some Work. Fig. 2 (Above)—Part of the Equipment Necessary for Molding a Tractor Engine

When the present organization took over the firm, it saw the necessity for close co-operation between the patternmaker and the foundrymen. The company also knew the value of accuracy in

Skilled Craftsmen

By

Norman F. Hindle

Fig. 3—Patternmakers Must Be Skilled Wood Workers

the construction of patterns. These two principles were followed, with the result that the business prospered and the company expanded its facilities. In 1927 a one-story experimental and engineering shop with 2400 square feet of floor space for making foundry jigs, checking fixtures, etc., was built. An assembling and shipping room was added to the original structure in 1928 and the most recent addition, which houses the wood pattern shop with 5500 square feet of floor space with a working area for 50 men, was constructed in May, 1929. New equipment was purchased at that time so that the company now operates one of the most completely equipped pattern shops in the country. The new addition which houses the wood pattern shop is a one-story, brick and steel structure with large windows that supply plenty of light to the workmen. Benches for the patternmakers are placed along the walls as shown in Fig. 5. The woodworking machinery is located in the central portion of the building. Roughing machinery such as planes and saws is arranged so that as many successive operations as possible may be performed on the wood as it is taken from the lumber storage. Machines are equipped with individual motors, push button control and suction apparatus to remove the dust and chips. Surface plates are located at convenient points in the room. These are used for making layouts and checking the patterns during the process of manufacture. The office of the patternmaker foreman and the pattern checker is located in the southeast corner of the building.

Machinery used in the wood working shop was supplied by the Oliver Machinery Co., Grand Rapids, Mich.; Yates-American Machine Co., Rochester, N. Y.; Edlund Machinery Co. Inc., Cortland, N. Y.; West Side Iron Works, Grand Rapids, Mich.; Syracuse Sander Co., Syracuse, N. Y.; Wonder Grinder Co., Erie, Pa., and the American Wood Working Machinery Co., Williamsport, Pa.

The machine shop is located at right angles

Fig. 4—A Group of Matchplates Made by the Company

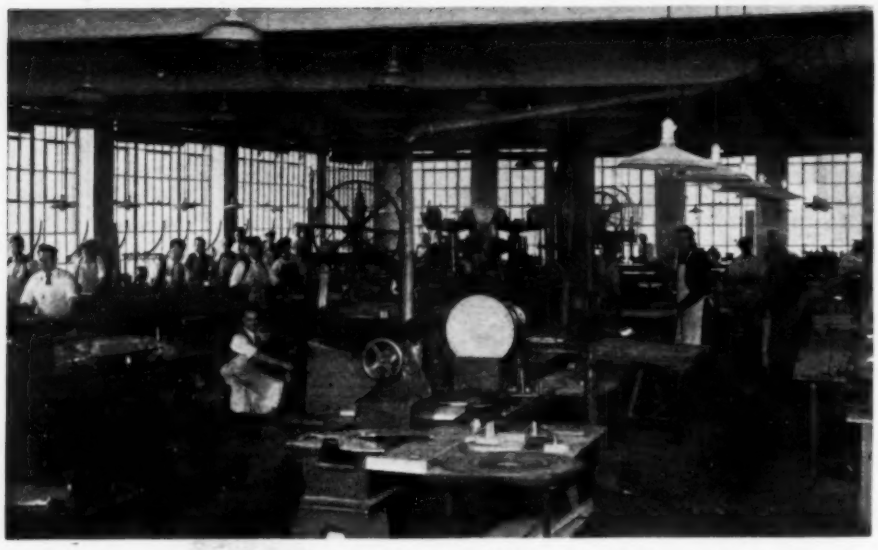


Fig. 5—Machinery Is Centrally Located With the Patternmaker's Benches Near the Windows

to the wood pattern shop in the old section of the plant. This shop is equipped to do all necessary machine work on metal patterns, regardless of size. As an illustration of the size of work that can be handled in this department, note the 96-inch boring mill in Fig. 1. The mill is shown machining a piston for the ventilating system on an ocean liner.

Machinery in the shop includes milling machines, nibbling machines, shapers, planers, lathes, boring mills, drills, presses, grinders, sanders, hack saws, arbor presses and filing machines. Practically all machinery is located along the east wall of the building. Midway on the east side is the tool room. Surface plates and layout benches for the metal pattern checkers and the layout men are distributed throughout the department. Machines of each type are grouped together as, for instance, the milling machines are located in the northeast corner of the building and the heavy machinery in the southeast corner. Chain hoists are located at convenient intervals throughout the building. Portable electric tools such as drills, screwdrivers, tapping machines and flexible shaft machines are supplied to the man whenever needed.

Although machine work is performed on the metal patterns wherever possible, much hand work is necessary. This is done at benches provided for that purpose and located along the west wall of the building as shown in Fig. 10.

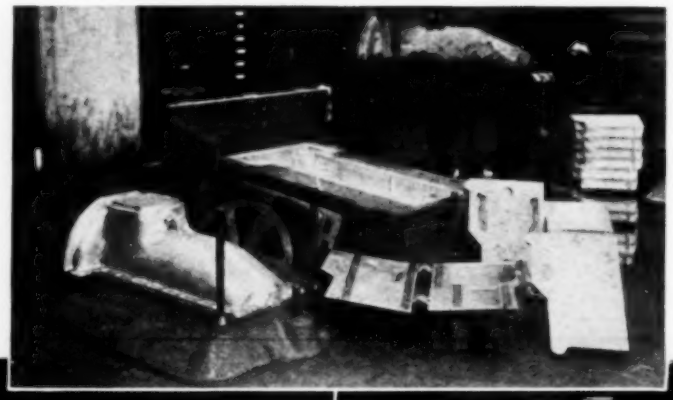
Machinery for the shop was supplied by the following firms: Colburn Machine Tool Co., Franklin, Pa.; the G. A. Gray Co., Cincinnati; Cenedy-Otto Mfg. Co., Chicago Heights, Ill.; Brown & Sharpe Mfg. Co., Providence, R. I.; Potter & Johnson Co., Pawtucket, R. I.; Hendey Machine Co., Torrington, Conn.; American Tool Works Co., Cincinnati; Wolcott Lathe Co., Jackson, Mich.; Peerless Machine Co., Racine, Wis.; Cincinnati Electrical Tool Co., Cincinnati; C. H. Besley & Co., Chicago; Cincinnati Milling Machine Co., Cincinnati and the South Bend Lathe Works, South Bend, Ind.

When an order for a pattern is received by the Motor Patterns Co., a committee composed of the executives of the company, and representatives of the foundry which will make the castings, the molding machine manufacturer and the flask maker meet in the firm's offices to determine the best and most economical method of molding to secure the desired production. If it is decided that the required pattern equipment should differ from that shown on the original drawings, the changes then are made. A layout is scratched on an aluminum sheet that has been coated with a blue stain that embodies those differences. This constitutes a permanent record of the job. After the job is completed these plates are filed away and held for a period of 3 to 4 years.

Makes the Templates

The closest dimensions are adhered to in the layout which includes a section of each part showing the parting lines, core partings, core prints, etc. Another layout then is made in a similar manner from which the templates are cut. Templates are pieces used to shape the correct contours of the various parts of the pattern. Metal templates are cut and machined to proper dimensions in the machine shop.

In the manufacture of patterns for production work which involves the use of metal patterns or matchplates, the first step is to make the master pattern of wood. White pine and mahogany are used in the construction of by far the majority of the patterns made in that shop. Pine is used for heavy and mahogany for light sections. The Motor Patterns Co. has the following specifications for the white pine that it uses: Moisture content, 7 per cent, maximum; free from pitch; free from shake and free from knots. The best white pine for patterns



Figs. 6, 7 and 8—Other Examples of Metal Pattern Work. These Are To Produce Tractor Engine Parts

is that which has been weathered properly. The moisture content of the lumber will be governed by the moisture of the air in district in which it is subjected to the weathering action. As an example, lumber weathered in Cleveland will have a different moisture content than lumber weathered in Birmingham. The degree of humidity in the community where the lumber is weathered automatically regulates the moisture in lumber. Patternmakers do not recommend the use of kiln dried lumber.

Shake is the name applied to slight openings in the grain of the wood which follow the growth rings of the log. Knots are classified according to size, shape and quality. They are pin, pencil, small, large or coarse in size; round, branch or spike in form and sound, loose, incased, pitch or rotten in quality. Other defects in white pine are sap, sap stain, checks, splits, pitch pockets, pitch streaks, wane, worm holes, chip grain, torn grain and loosened grain.

Begins Construction

Construction of the master pattern begins with the removal of the wood from the lumber storage room. The pattern or piece for a pattern may be cut from one piece of stock or it may be shaped from a laminated structure made of several pieces of wood that have been glued together. If the former method of manufacture is to be used, the piece is sawed and planed on all sides in machines provided for that purpose and then the work of shaping the pattern may be started. If the latter method of construction is used, each of the several pieces is planed on all sides and glued together in whatever form desired. The pieces then are placed in clamps which remain in place until the piece has dried thoroughly. Complete drying usually requires several days.

Several patternmakers may be assigned to one job or one man may complete the entire pattern. This depends on the size and shape of the pattern being constructed. Before beginning the construction of a wood master pattern, it is necessary to get the job thoroughly in mind by studying the blueprints. Stock then is removed from the lumber storage and cut out to as near the proper shape as possible. That is done on planers, band saws, lathes or other equipment. Sometimes a pattern may be practically completed on the machines but in the majority of cases most of the work must be done by hand. Irregular surfaces are hand tooled and the contours are checked by the use of the templates referred to previously. All work involves extreme accuracy. As the pattern begins to take shape, a layout is made in pencil on a smoothly planed board. This shows the contour of the assembled pattern along the center line. This layout is not made for all patterns but is necessary in the manufacture of intricate ones. The contours of the pieces that make the assembled, master pattern are checked repeatedly using the layout as a guide. As each piece is finished or has reached a stage where it is necessary to fit it to other parts, it is glued in place again using the layout as a guide. That procedure was followed in the construction of the pattern in Fig. 3.

When the pattern is assembled completely, it is given a final check. All dimensions must be correct with the proper allowances made for draft, shrinkage and machining. All master patterns are made with a double shrinkage allowance. One is made for the alloy from which the metal pattern is cast and the other is for the final casting shrinkage. Draft is not standard. It varies both with the type of work and the desire of the customer that places the order.

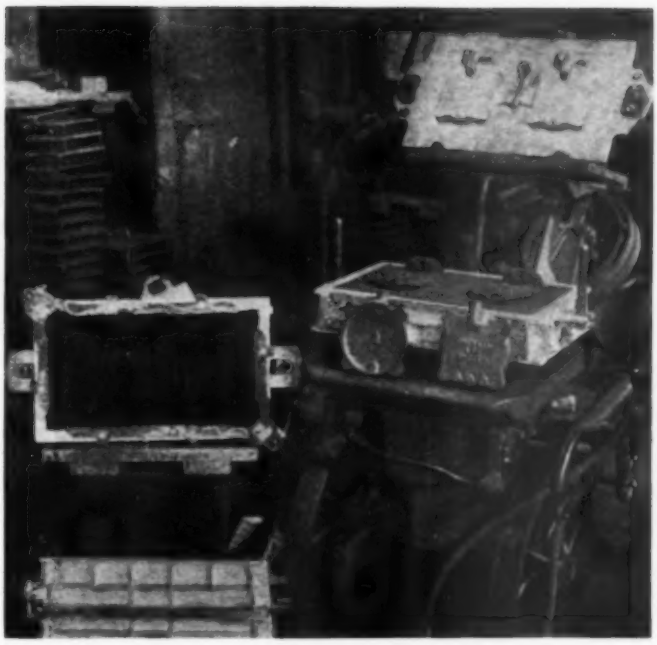


Fig. 9—Pattern, Mold and Sample Castings for a Simple Matchplate Job

If the master patterns are correct in every detail, they are given a coat of shellac. The following designations are used. If the pattern casting is to be cast iron and the master pattern is made of pine, that part of the pattern which forms the metal surface is painted black and the core prints red. If the pattern is made of mahogany, orange shellac is used to designate the metal and black is used on the core prints. That part of the pattern which forms the metal surface is painted black and the core prints yellow for steel pattern castings. Yellow is used on the casting's surface and black core prints are used for brass and aluminum pattern castings.

The master pattern then is ready to be cast in the foundry. Production patterns usually are made of aluminum, brass or cast iron. Aluminum patterns are made from No. 12 alloy which contains 8 per cent copper and 92 per cent aluminum. Brass patterns are made from the 85-5-5-5 alloy which contains 85 per cent copper, 5 per cent tin, 5 per cent lead and 5 per cent zinc. Cast iron patterns are made from a nickel alloy iron which is annealed before machining to eliminate warpage and casting strains. The method of casting matchplate patterns should be of interest. Pat-

Fig. 10—View of the Metal Working Shop

terns with regular partings are cast easily but those with irregular partings are more difficult. In molding the latter type pattern, a false cope is rammed and the pattern bedded in and the parting cut. Parting compound then is shaken over the cope surface and the drag flask placed on the cope and rammed. The mold is clamped, rolled over and the false cope lifted from the drag. The false cope is destroyed. Parting compound then is shaken over the surface of the drag, and the cope is placed in position and rammed. The cope then is lifted from the drag and the pattern drawn. The mold is finished all over and metal strips the desired thickness of the matchplate are placed along the edges of the flask. These strips also have machining allowances for the matchplate. Sand then is built up on the drag and shaped to the contour for the plate. The cope is placed on the drag and the mold is poured.

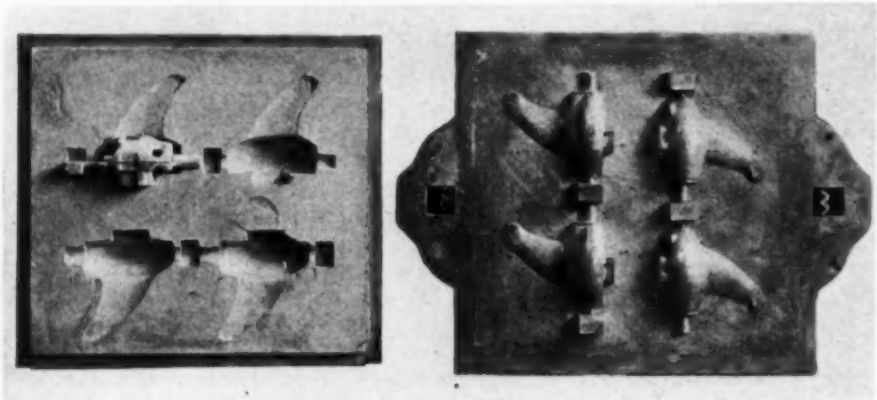


Fig. 11—Plaster of Paris Cores Are Made and Set in a Mold Made of the Same Material to Check the Metal Thicknesses

When the casting has been returned to the pattern shop, it is ready for machining. Wherever possible operations are performed on machines but often it is necessary to do a great deal of hand tooling on the intricate patterns. The patterns are machined and finished the same as in die work. This often necessitates the making of cutters to form irregular contours which cannot be machined with the cutters available. Tolerances in the machining operations are small. Only a few thousandths are allowed. In stripper plate work the clearances are extremely small. In matchplate work the castings generally are made as previously described but sometimes the two halves of the pattern are cast, machined and mounted on finished aluminum plates. A group of matchplates is shown in Fig. 4.

After the metal patterns are complete, they are checked for dimensions. If satisfactory, plaster of paris molds are made. If any cores are necessary in producing the casting, they are made in plaster and set in the mold. The metal thicknesses and dimensions then are checked from the plaster mold. Sample castings also are made if the customer desires them. Fig. 11 shows a matchplate with the plaster mold and the cores set in one cavity. This is for an outboard motor casting. Fig. 9 shows the complete molding equipment and sample castings for a simple job on a squeeze type machine.

The construction of core boxes is carried out along the same lines of accuracy and workmanship as the casting patterns. Most coreboxes made by the company are equipped with steel strips along the strickoff face of the boxes to reduce wear. This protection consists of steel strips along the corners. Often these strips cover the entire top surface. In some cases the core cavities are lined with steel to reduce wear. The strips are made of a standard gage steel so that in case of wear they may be replaced easily.

The company points with pride to what it considers a record. It recently made the patterns for a complete 8 cylinder, 7 bearing motor and crankcase which included brass cope and drag patterns mounted on cast steel bolsters and stripping plates for jar ramming machines, a full set of aluminum steel faced core boxes, aluminum core dryer patterns and sample dryers, steel faced aluminum core filing jigs and aluminum core setting jigs. Plaster molds were made and the patterns checked. Patterns were delivered to the customer, sample castings made and checked and the patterns placed in production 7 weeks after the order was received.

The Motor Patterns Co. has made patterns for foundries in Russia, Japan, Mexico, Germany and Australia. It recently finished an order for complete pattern equipment for a tractor foundry in Russia. This order offered a complex problem in designing. The daily production of the foundry was known and from these figures the required number of patterns and the flasks were designed and other equipment was made. Molding machine units of cope and drag were balanced to produce a given quantity each day. The equipment was constructed in such a way that it was practically impossible to mix the various parts during production. Each part was marked in Russian. The cope and drag flasks were marked and the front was designated. Core boxes were numbered so that it was impossible to set the cores in the wrong place. One flat sided and one round pin were used on the patterns and the flasks were designed to fit the pins with a round hole on one side and a slotted hole on the other. This provided for the expansion of flasks during continuous pouring and prevented the flasks from being closed wrong. Gates, sprues and risers were mounted on the patterns. Every possibility was taken into consideration for the protection of the customer. When the pattern equipment was received, it could have been placed in production immediately.

Eleven sample castings were made from each part of the equipment. One was checked by a representative of the Russian foundry and the others were sent to the manufacturers who were designing the jigs for the machining operations. The company also designed and made water testing fixtures for the cylinder and cylinder head castings and a complete set of gages for checking the rough castings. A part of the equipment is shown in Figs. 2, 6, 7, and 8.

New England Founders Hear Smalley

The regular monthly meeting of the New England Foundrymen's association was held at the Engineer's club, Arlington and Commonwealth avenue, Boston on March 12. Oliver Smalley, consulting foundry specialist and metallurgist, was the speaker of the evening. He gave an illustrated talk on "Foundry Problems." Among the subjects discussed were cupola practice, running and feeding of castings, elimination of shrinks and the effect of alloys on the physical properties of cast iron and semisteel.

Leeds & Northrup Co., 4901 Stenton avenue, Philadelphia, manufacturers of temperature measuring instruments, has moved its Cleveland office from 1228 to 1941 Union Trust building.

How Can Brass Foundries Stabilize Business?

Industry Must Develop Cost Accounting and Study Merchandising Methods To Realize Profit In Competitive Markets

By Willard E. Freeland

WHAT business problems are we facing? According to economists we are in a long period of steadily declining commodity prices. It is predicted that the end of this swing may not come until 1942 or thereabout. Such being the case, we can see readily that there will be great pressure upon the profit margins of business because price always decline before the unit cost of production declines. Therefore, we will have not only our continuing problem of distribution to face, but will be forced to take a renewed interest in the problems of production.

Considers Technical Advances

In the first place it is necessary to consider all the phases of the technical advances in the fields under consideration. That is particularly true in the fields of metal working. Also it is necessary to give attention to production costs. That will be true particularly of the industries which have not gone far in establishing uniform cost systems nor in establishing standard costs. Many probably will agree that brass founders could be charged with having done relatively little development of costs in the sense that the larger industries have developed cost accounting. It is quite characteristic of the brass foundry industry to be afraid of the nonproductive or, as the accountants call them, the indirect costs. Therefore there has been little adoption of such types of work as genuine cost accounting. It is interesting to find, after a study of business as a whole, that the weaker industries nearly always are characterized by low indirect costs. These industries have not learned that it is impossible to have good policies, sound profits, and correct prices, unless they have the data upon which such elements of business must rest.

Much is said today about research. To the minds of many business men this is some far-fetched and costly scheme by which they secure advantages that the little fellow cannot hope to have. It is true that the bigger industries do finance comprehensive and perhaps costly research departments but it is only the element of first cost which is costly. The real gain comes from the presence of these research departments. On the other hand, the smaller man in business is not shut out from research. There are plenty of professional groups and educational institutions in this country which carry on fine research work for the small man at costs which are within his reach. He is not informed of the opportunities which lie at his door and of the values which come from research. This prevents him from being relatively as active in this field as is the giant industry.

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Must Conduct Research

Looking forward to the kind of competition which will prevail from now on in this country, it is quite necessary to have research into the character of the product, into methods and processes, into various costs of processing and distribution, and into the services which are going to be required of manufacturers who stay in business for the next 15 years. This question of services to be rendered, if any research is done at all in it, opens the door inevitably to the other kind of research work which should go on in every active industry.

Of course production is not going to be the whole story. There is also the question of marketing which always is present. Marketing has at least three major phases: The actual work of selling, the supporting work of sales promotion, and once again the factor of service to customers which goes with the marketing end of industry.

It is true of every foundry business, but particularly true of the brass foundry industry, that there are certain trade evils which prevail. One of these is quoting prices on a pound basis instead of by the piece or by the pattern. There is really no defense for quoting prices by the pound except that of tradition which

is not a form of defense. Again there prevails a habit of absorbing certain costs which should have been charged to the customer such as the making of patterns, extensive changes in patterns, and other elements of a similar nature.

Again there has been altogether too much willingness to quote prices upon what we call the *burden absorbing basis*. That is to say, the small foundryman, finding himself somewhat out of work and desiring to hold his forces together, justifies any price cutting in which he may indulge upon the fact that it will help to carry some of his burden and keep his plant in operation. Under some circumstances that is a thoroughly excusable type of operation, but in a great many cases there is another form of cure for it. This cure lies in more energetic selling and the development of more skill in selling.

Outlines Development

When the average brass founder gets into that business, he goes through three stages of development: First, that of the craftsman; then that of the buyer; and last that of the seller. The trouble with a great many men in the brass foundry business is that they have stopped their development at the buying stage and take vastly more pride in being able to buy at half a cent a pound less than they do in being able to sell their product at a cent a pound higher, whereas the opposite should be the case. What this really means is that the man running the business has not yet become in the true sense the manager of a business.

What does this type of management mean? How many in the brass foundry industry have a budget of expected sales for 1930 and a budget of expected expenses? How many have a definite plan for a sales campaign extending throughout the year? How many have established specific methods of control of this business to see that plans are really carried into execution? The author feels confident that few have these mechanisms of management present in their businesses. Yet such plans are not hard to put into execution although when first tried, they may not be too accurate. Accuracy comes with practice.

Again, due to prior training of the men in many businesses, too little interchange of ideas and too much of suspicion of the other fellow exists. That situation is changing because of various organizations but there is a great time factor and there will always be laggards in such organizations who have not taught themselves to interchange ideas freely or to accept the idea that you can get only as you give. It is this latter idea which removes suspicion from business.

Another factor which affects management is the presence of adequate standards. As progress is made toward scientific management there is less and less room for the man who quotes a low price to get a job and does it with the deliberate intention of cutting something out of the product so that he can make some profit. Standards of that kind will not stand the inspection which large purchasers give to the component parts which they get from various manufacturers.

Standards are not something superimposed from the outside by explicit commands or orders, but something which grows up within the heart of the individual and hence in the heart of the corporation which is much more effective and has more to do toward building good-will and future business than any amount of mere commands.

How many managers know anything about the various types of operating ratios by which executives today keep a watchful eye upon each and every division of their business? If you know nothing about them, considerable information may be obtained from books and articles dealing with the subject. Recently the author sat at dinner with the manager of a large hotel and heard him tell how each of the 18 operating divisions in the hotel is governed by operating ratios and how they hold a group meeting every Thursday morning to go over these various operating ratios and analyze the cause for any report which may be disturbing in its character. Nothing is involved or unusually mathematical in the use of the operating ratio. It is only one of the forms of executive reports which a manager should have to have a continuing, successful business.

Explains Attitude

The Associated Brass Founders of New England is to be commended for its work. I have been interested in talking with some of the members about the evils they feel exist due to the attitude of the typical purchasing agent, and also their feeling of helplessness in dealing with the situation. The assumption seems to be that the purchasing agent is an all-powerful individual whose main object in life is to save a quarter or a half a cent or a cent wherever he can. Attendance at some of the meetings of the purchasing agents association, would show that other factors than price must enter into his consideration. The intelligent purchasing agent is one who has to pay just as much attention to the character of service that the seller is going to give him and to the technical skill of that vendor and his organization as he is to the mere matter of price. To the right kind of salesmen of brass castings the purchasing agent is not necessarily an impediment.

Back of the purchasing agent is a requisition or a series of requisitions coming from some plant engineer or production man which practically dictate the kind and quality of brass castings which are wanted for specific purposes. Most purchasing agents are grateful for the right kind of technical help which will result in superiority of service for specific needs, or some method or form of reducing the cost of brass castings which are component parts of the product. It practically always is possible to sell the men who make the requisitions but the brass founder who is going to do that must have something more than a mere chunk of cast brass.

Book Review

Der Industrieofen in Einzeldarstellungen, Part III, Abmessungen von Hoch und Martinofen, by Michael Pavloff, paper or cloth, 148 pages, 6¾ x 9¼ inches, published by Otto Spamer, Leipzig, Germany, and supplied by THE FOUNDRY, Cleveland, for $4 in paper and $4.75 in cloth plus 15 cents postage, or in London by the Penton Publishing Co. Ltd., 415-17 Caxton House, Westminster, for 20s in paper and 23s 9d in cloth, postage extra.

This work, originally in Russian, was translated into German by Prof. Dreyer and constitutes the third volume of a series on special applications of industrial furnaces edited under the direction of the late L. Litinsky. The book deals specifically with the dimensions of blast furnaces and open-hearth furnaces. The first two chapters in the book relate to the blast furnace and present such data as the development of the dimensions and profile of blast furnaces and the determination of blast furnace dimensions from data given. The remaining five chapters are devoted to a discussion of open-hearth furnaces and include the development of the dimensions and construction of the open hearth, dimensions of open hearths according to investigated data, material and heat balance of the open-hearth process, application of the material and heat balances to calculations of the open hearth, and control of the dimensions of a 100-ton open hearth. In the appendix seven folded tables give dimension data on blast furnaces and open hearths, and diagrams showing the construction.

GRAY IRON

Possesses

Valuable Engineering Properties

Part III

GRAY cast iron is a series of alloys. To make intelligent comparisons it is necessary to classify these alloys into various groups. Carbon and silicon are the most important elements from an engineering viewpoint. It has been found that in irons made by similar processes, variations in mechanical properties, particularly hardness and strength, are proportional to the percentage of those elements present. Usually they are proportional to the ratios of the sum of total carbon plus 0.3 times the silicon. A classification according to silicon and carbon content is shown in Table I. Silicon and total carbon are important in that to a large degree they control the amount of graphite.

With other factors equal, the greater the percentage of total carbon and of silicon, the greater the amount of graphite. Under such conditions the strength varies *inversely* with the percentage of these elements. In addition to chemical constitution another important variable is cooling rate.

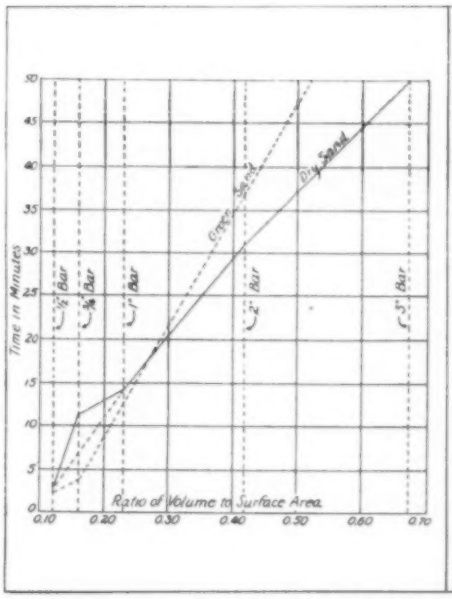
Groups the Alloys

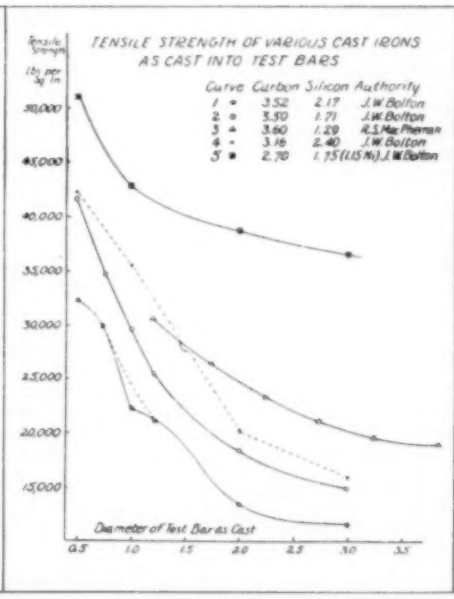
SINCE the composition of gray iron varies between wide limits, some definite system of classification or grouping should be used in comparing the various types. Cooling conditions also have considerable effect upon the physical properties and should be taken into account as is pointed out in this article which is the third on the engineering properties of gray iron. The value of the tensile strength test for gray iron also is shown and the stress-strain diagram for this material is explained.

The *degree* of graphitization, that is the relative proportions of graphitic and combined (or pearlitic) carbon are influenced by the cooling rate. The faster the cooling rate, the greater proportion of *pearlite* compared to graphite, up to that rate at which the primary cementite has not decomposed and white irons are obtained.

Cooling rate increase *hinders* graphitization and increase of silicon promotes it. Hence, for greater strength in an iron of given total carbon content just enough silicon should be added to produce a pearlitic matrix. An excess will cause some of the pearlite to break down, forming the weaker ferrite and more graphite. In addition to its effect on degree of graphitization, cooling rate influences the grain *size*. Slow cooling causes large grain size. To establish exact cooling rate of a casting it is necessary to use a pyrometer—a time consuming and tedious task which is not practical for every day foundry use.

However, relative cooling rates can be established with fair accuracy. For example, the volume of metal in the casting, if poured at a given temperature, represents the heat energy to be dissipated. The surface area of the casting is the exposed area from which the heat must be dissipated. With like pouring temperature and similar sand conditions, the actual




TENSILE STRENGTH OF VARIOUS CAST IRONS AS CAST INTO TEST BARS
Curve Carbon Silicon Authority
1 3.52 2.17 J.W. Bolton
2 3.50 1.71 J.W. Bolton
3 3.60 1.29 R.S. MacPherran
4 3.16 2.40 J.W. Bolton
5 2.70 1.75 J.W. Bolton
Diameter of Test Bar as Cast

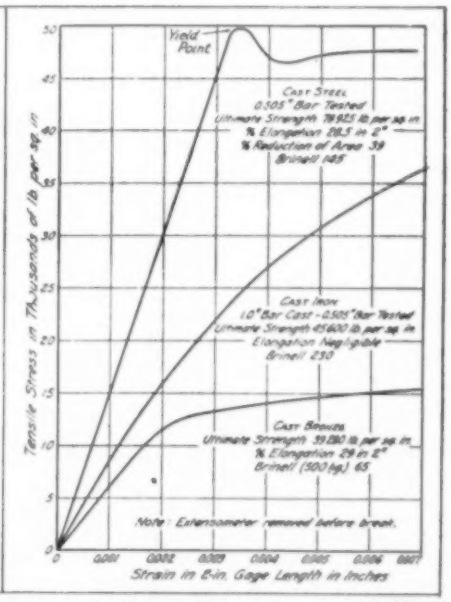

Yield Point
Cast Steel
0.505" Bar Tested
Ultimate Strength 79,925 lb. per sq. in.
% Elongation 28.5 in 2"
% Reduction of Area 39
Brinell 185
Cast Iron
1.0" Bar Cast - 0.505" Bar Tested
Ultimate Strength 45,600 lb. per sq. in.
Elongation Negligible
Brinell 230
Cast Bronze
Ultimate Strength 39,280 lb. per sq. in.
% Elongation 29 in 2"
Brinell (500 kg.) 65
Note: Extensometer removed before Brinell.
Tensile Stress in Thousands of lb. per sq. in.
Strain in 8-in. Gage Length in Inches

FIG. 18—CURVES SHOWING THE RELATION OF COOLING TIME TO RATIO OF VOLUME TO SURFACE AREA. FIG. 19—TENSILE STRENGTHS OF VARIOUS TYPES OF CAST IRON DETERMINED ON STANDARD TEST BARS. FIG. 20—STRESS-STRAIN DIAGRAMS FOR STEEL, CAST IRON AND BRONZE

Table I

Classification of Cast Irons on Si + C Content

Group No.	Carbon	Silicon	Carbon and 0.30 Silicon		Carbon and Silicon	
1	Above 3.50	Above 2.50	4.25	up	6.00	up
2	Above 3.50	2.26–2.50	4.21	up	5.88	A
3	Above 3.50	2.01–2.25	4.14	up A	5.63	C
4	Above 3.50	1.76–2.00	4.06	B	5.38	E
5	Above 3.50	1.51–1.75	3.99	C	5.13	G
6	Above 3.50	1.26–1.50	3.91	D	4.88	I
7	Above 3.50	1.01–1.25	3.83	E	4.63	K
8	Above 3.50	0.76–1.00	3.76	F	4.88	M
9	3.26–3.50	Above 2.50	4.13	up A	5.88	up A
10	3.26–3.50	2.26–2.50	4.09	B	5.76	B
11	3.26–3.50	2.01–2.25	4.02	C	5.51	D
12	3.26–3.50	1.76–2.00	3.94	D	5.26	F
13	3.26–3.50	1.51–1.75	3.87	E	5.01	H
14	3.26–3.50	1.26–1.50	3.79	F	4.76	J
15	3.26–3.50	1.01–1.25	3.71	G	4.51	L
16	3.26–3.50	0.76–1.00	3.64	H	4.26	N
17	3.01–3.25	Above 2.50	3.88	up D	5.63	up C
18	3.01–3.25	2.26–2.50	3.84	E	5.51	D
19	3.01–3.25	2.01–2.25	3.77	F	5.26	F
20	3.01–3.25	1.76–2.00	3.69	G	5.01	H
21	3.01–3.25	1.51–1.75	3.62	H	4.76	J
22	3.01–3.25	1.26–1.50	3.54	I	4.51	L
23	3.01–3.25	1.01–1.25	3.46	J	4.26	N
24	3.01–3.25	0.76–1.00	3.39	K	4.01	O
25	2.76–3.00	Above 2.50	3.63	up H	5.38	E
26	2.76–3.00	2.26–2.50	3.59	H	5.26	F
27	2.76–3.00	2.01–2.25	3.52	I	5.01	H
28	2.76–3.00	1.76–2.00	3.44	J	4.76	J
29	2.76–3.00	1.51–1.75	3.37	K	4.51	L
30	2.76–3.00	1.26–1.50	3.29	L	4.26	N
31	2.76–3.00	1.01–1.25	3.21	M	4.01	O
32	2.76–3.00	0.76–1.00	3.14	N	3.76	P
33	2.51–2.75	Above 2.50	3.38	up K	5.13	G
34	2.51–2.75	2.26–2.50	3.34	K	5.01	H
35	2.51–2.75	2.01–2.25	3.27	L	4.76	J
36	2.51–2.75	1.76–2.00	3.19	M	4.51	L
37	2.51–2.75	1.51–1.75	3.12	N	4.26	N
38	2.51–2.75	1.26–1.50	3.04		4.01	O
39	2.51–2.75	1.01–1.25	2.96		3.76	P
40	2.51–2.75	0.76–1.00	2.89		3.51	

NOTES: Manganese on most foundry irons runs between 0.45 and 0.80, within which range no sub-classification seems necessary.

Phosphorus subdivisions might be 0–0.15, 0.16–30, 0.31–0.50, 0.51–0.70, 0.71–1.00. This element influences the stiffness of the metal and also is a factor in its fluidity and hardness.

At the present time no logical subdivisions on sulphur content have occurred to the writer. Perhaps the sulphur/manganese ratio will furnish a basis for further classification.

Nickel and chromium have powerful influences on cast iron, and irons containing them exhibit somewhat different characteristics than "Straight" silicon-carbon, irons.

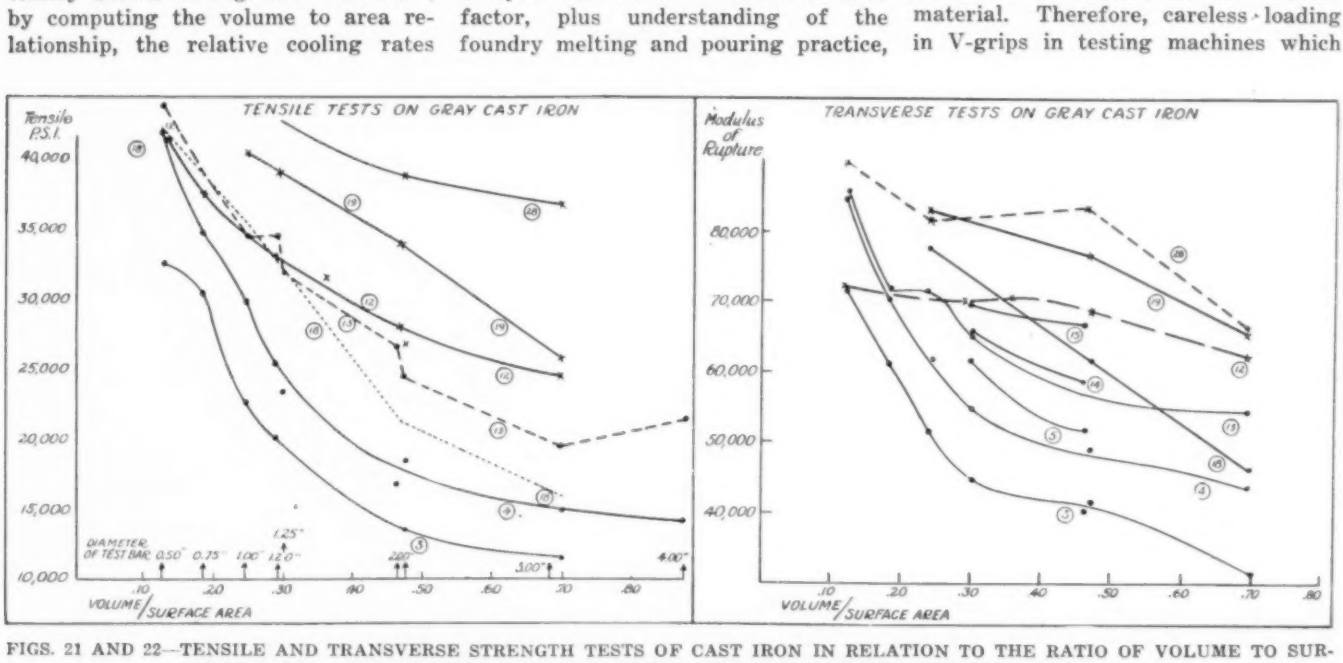
cooling rate is directly related to the ratio of volume in cubic inches to surface area in square inches. This is clearly shown in Fig. 18. Therefore, by computing the volume to area relationship, the relative cooling rates of various simple shapes may be established by simple mathematical methods. So, with knowledge of the analysis and of the volume to area factor, plus understanding of the foundry melting and pouring practice, a position is attained where intelligent comparisons can be drawn. In most cases the mechanical properties of the metal in the casting may be determined with fair accuracy by interpolation from curves of a series of test bars of various sizes.

The foundryman for many years has made practical use of a similar scheme, as he always has adjusted his iron mixture to the section size (or wall thickness) of his casting. The volume to area ratio for a number of bar shapes is shown in Table II. Charts showing the relationship between the volume to area ratio and certain mechanical properties are indicated in Figs. 21 and 22.

Tensile Test Is Useful

A desirable feature of the scheme is that it makes possible a reasonable correlation of mechanical properties of test bars and of castings of similar analysis. The aim of all engineering tests is to establish a relationship between test results and service properties, and thence to predict expected service from basis of test results. It has become possible to do this for many materials, and with sufficient accumulation of data and research it will become possible for gray iron.

The tensile test for gray cast iron has not received the prominence it deserves. The prevailing impression which is largely erroneous is that slight lateral stresses with long moments are present in all test bars and cause them to break, partly due to these forces rather than from the straight tensile pull. Thus, it is supposed, that tensile stress values are in error. It is true that gray iron although stretching quite readily within narrow limits, is not a ductile material. Therefore, careless loading in V-grips in testing machines which



FIGS. 21 AND 22—TENSILE AND TRANSVERSE STRENGTH TESTS OF CAST IRON IN RELATION TO THE RATIO OF VOLUME TO SURFACE AREA. THE FIGURES IN THE CIRCLES REFER TO THE GROUP NUMBERS IN TABLE I

are seriously out of alignment, is likely to give false results.

With simple and reasonable precautions these obvious sources of error may be eliminated and trustworthy results obtained. The Robertson shackle shown in Fig. 25 is a device designed to eliminate lateral stresses. As it is automatically self-centering and practically frictionless, it is extremely well-adapted to tensile testing of brittle materials. After making a number of carefully conducted comparisons between tests made on Robertson shackles and those with the ordinary ball-joint arrangement, Bolton concluded that the test made with the latter method are sufficiently accurate for any practical purpose. As a matter of fact, series of parallel tests will average within 2 or 3 per cent. Furthermore, when reasonable care is used, wedge grips can be employed successfully. By casting a specially shaped bar shown in Fig. 26, it is possible to obtain a fair alignment without a special centering device.

Cast Bar to Size

In making tensile tests on gray iron the more usual practice is to machine test bars from a cast test piece or coupon. The material thus tested represents the center of the section and hence its weakest and most unsound portion. This is part of the reason that transverse moduli of rupture are higher than directly determined tensile stresses. To obviate machine difficulties the bar shown in Fig. 23 has been proposed by L. W. Spring, and adopted by the American Society for Testing Materials for determining physical properties of gray cast iron for valves, flanges and fittings. This bar, as may be observed, is cast horizontally in conjunction with the regular 1.2-inch diameter x 13-inch transverse test bar. This provides an excellent bar for routine control. The ends are threaded and

Table II

Volume to Surface Area Relationships

	Size of bar Inches	Length cast	Length between supports	Cross section area	Surface area sq. in.	Volume cu. in.	Volume / Surface area	Relative Mod. Rup.	Log Mod. Rupture
1	¼x12x12						.1200		
2	0.500 d.	21	18	.196	33.4	4.12	.1234	366.640	2.56425
3	0.800 d.	15	12	.503	38.7	7.55	.1951	59.672	1.77577
4	0.875 d.	21	18	.601	58.9	12.6	.2139	68.414	1.83514
5	⅜x12x12						.2308		
6	1.00 d.	15	12	.785	48.7	11.8	.2423	30.552	1.48504
7	1.00 d.	21	18	.785	67.5	16.5	.2444	45.831	1.66116
8	1x1	27	24	1.00	110.0	27.0	.2455	36.0	1.55630
9	1.20 d.	21	18	1.131	81.4	23.8	.2924	26.523	1.42362
10	1.25 d.	15	12	1.227	61.4	18.4	.2997	15.666	1.19496
11	1.30 d.	21	18	1.327	88.4	27.9	.3156	20.860	1.31931
12	2x1	27	24	2.00	166.0	54.0	.3253	18.0	1.25527
13	1x2	27	24	2.00	166.0	54.0	.3253	9.0	0.95424
14	1.40 d.	21	18	1.539	95.4	32.3	.3386	16.702	1.22277
15	1.50 d.	15	12	1.767	74.2	26.5	.3571	9.052	0.95674
16	1.50 d.	21	18	1.767	102.5	37.1	.3620	13.579	1.13287
17	1.5x1.5	27	24	2.25	166.5	60.75	.3650	10.67	1.02816
18	1x12x12						.4286		
19	2.00 d.	15	12	3.142	100.5	47.1	.4686	3.819	0.58195
20	2.00 d.	21	18	3.142	138.2	66.0	.4776	5.7288	0.75806
21	2x2	27	24	4.00	224.0	108.0	.4820	4.500	0.65321
22	2.20 d.	21	18	3.801	152.7	79.8	.5226	4.3042	0.63389
23	2.50 d.	21	18	4.909	174.8	103.1	.5898	2.9332	0.46734
24	2.5x2.5	27	24	6.25	282.5	168.75	.5980	2.303	0.36229
25	3.00 d.	15	12	7.069	155.5	106.0	.6817	1.1316	0.05369
26	3.00 d.	21	18	7.069	212.1	148.4	.6996	1.697	0.22968
27	3x3	27	24	9.00	342.0	243.0	.7110	1.333	0.12483
28	2x24x24						.8571		
29	4.00 d.	15	12	12.57	213.6	188.6	.8830	.477	9.67852–10
30	3x24x24						1.20		
31	6.00 d.	15	12	28.27	339.3	424.1	1.250	.141	9.14922–10
32	4x24x24						1.440		
33	8.00 d.	15	12	50.27	477.5	754.1	1.579	.0596	8.77525–10

NOTES: Assuming same pouring temperature, like specific heats, and like liquid gas content, heat energy as cast of bars of given analysis is roughly proportional to VOLUME. Potential energy (total) also varies according to the allotropic modifications (delta, gamma, beta, alpha) and that due transformations like cementite—ferrite—graphite or austenite—pearlite.

Assuming same conductivity on medium (mold) COOLING RATE is roughly proportional to the ratio $\frac{\text{VOLUME}}{\text{SURFACE AREA}}$

$\text{SURFACE AREA} = \pi DL_n - \frac{\pi D^2}{2}$ $\quad \text{VOLUME} = \frac{\pi D^2 L_n}{4}$ (Ln = length as cast)

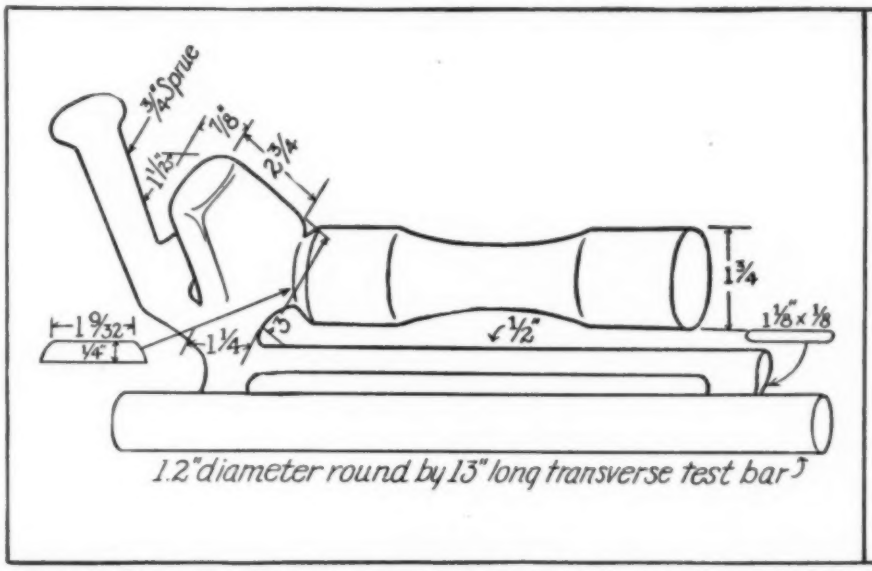
$\text{MODULUS OF RUPTURE} = \frac{SLS}{\pi D^3}$ or 2.546LS for round, $\frac{D^3}{3LS}$ for square $\frac{3LS}{2BH^2}$

L = distance between knife edges S = breaking load D = diameter

Now this formula is for elastic beams, and assumes c.g. on geometric axis of bar. This is not true for cast iron, c.g. varying as elastic limits in tension and compression are dissimilar. However the MR gives good comparisons.

The ratio of $\frac{\text{VOLUME}}{\text{SURFACE AREA}}$ plotted against bar diameter is almost a straight line for diameters up to three inches and as cast lengths of 15" or over. Thus DX0.24 = the ratio. Or the relative cooling rate is almost proportional to the diameter.

Plotting relation of diameter to relative modulus of rupture gives a curve of the hyperbolic type.



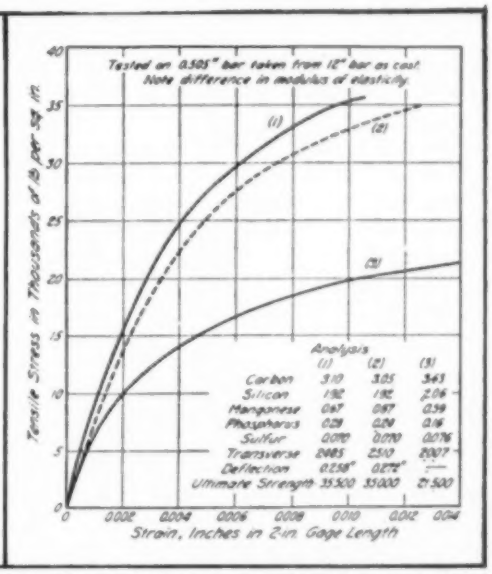

Tested on 0.505" bar taken from 1" bar as cast
Note difference in modulus of elasticity
(1)
(2)
(3)
Tensile Stress in Thousands of lb. per Sq. in.
Strain, Inches in 2 in. Gage Length
Analysis (1) (2) (3)
Carbon 3.10 3.05 3.43
Silicon 1.92 1.92 2.06
Manganese 0.67 0.67 0.59
Phosphorus 0.09 0.09 0.16
Sulfur 0.070 0.070 0.076
Transverse 0.485 2.510 0.907
Deflection 0.238" 0.272" —
Ultimate Strength 35,500 35,000 21,500

FIG. 23—SKETCH OF TENSION AND TRANSVERSE TEST BARS AS CAST. FIG. 24—COMPLETE TENSILE, STRESS-STRAIN DIAGRAMS FOR DIFFERENT TYPES OF CAST IRON

screwed into adapters and used either with the Robertson shackles or the ordinary ball joint holders.

Ultimate tensile tests of gray iron range from 20,000 pounds per square inch for the low to 60,000 pounds per square inch for the high grades of engineering castings. Fig. 20 shows typical stress-strain curves of gray cast iron, bronze and cast steel. In a later section it will be shown that on repetition of stress approaching the elastic limit, the stress-strain relationship of cast iron approaches a straight line with a well-defined elastic limit. It is evident that much careful work must be done to establish the true mechanical expectancy of various grades of gray iron.

Every time a load (stress) is placed on a piece of metal there is a certain amount of stretch (strain). If we take a tensile bar, place an extensometer (a delicate instrument for measuring changes in length between given points on the bar i. e., for measuring the stretch or strain) on it, and gradually load the bar, the extensometer shows the amount of strain usually measured in thousandths of an inch between points 2 inches apart on the original bar. If *stress* is plotted against *strain*, curves as shown in Fig. 20 are obtained. These curves are known as stress-strain curves.

In their lower ranges (where the ratio of stress to strain is constant, according to Hookes law) these curves show the relative stiffness of the various materials. In the accompanying chart, for example, to produce a 0.001-inch strain in steel required 15,000 pounds per square inch load. In the cast iron only 8000 pounds per square inch was needed to produce the same strain, and in the bronze about 6000 pounds per square inch. Therefore, steel is the most *rigid* of the three materials, the cast iron next, and the bronze last. Rigidity, or stiffness, is desirable in certain designs, hence, for given rigidity the engineer must use a little more iron or bronze than steel. This amount varies according to the type of section and its service, and except in straight tension may be less than the relative figures on the test bars.

If the curves at 0.003-inch strain are examined it may be seen that the iron and bronze curves no longer approximate a straight line whereas the steel curve still approximates a straight line. Taking the bronze for example, at about 11,000 pounds per square inch, stress and strain are no longer proportional, and for greater loads a large strain or stretch occurs with each added increment of stress. If the stress had been removed when the bronze was at the 0.001-inch strain, the strain would have gone back almost exactly to zero. At 0.003-inch, when the load is removed, the strain largely remains due to the fact that the material is stretched permanently because its *elastic limit* has been exceeded. This elastic limit (say at 11,000 pounds per square inch or to be more precise, the true proportional limit on long time loading, which is much less than the commercial elastic limit) is beyond the ultimate *useful strength*, for the material takes a permanent set or deformation before this load is reached. With greater loads it simply stretches completely out of shape. Thus, although the test bar indicates that the metal has an ultimate strength of 39,280 pounds per square inch, not

Table III

Routine Tensile Tests

Carbon	Silicon	C+0.3 Si	Tensile Strength
3.04	2.19	3.70	41,575
2.95	2.29	3.64	36,740
2.99	2.37	3.70	39,450
2.94	2.38	3.65	35,890
2.83	2.29	3.52	37,200
2.88	2.44	3.61	37,785
2.83	2.40	3.55	40,970
2.91	2.38	3.62	38,625
2.90	2.38	3.63	39,615
3.01	2.42	3.75	36,690

Routine tests on 10 consecutive days on machinable iron for medium castings.

First of Ladle	Middle of Ladle	Last of Ladle
28,870	28,100	27,930
28,930	30,500	28,830
28,470	29,570	29,350
29,350	27,800	26,550
27,520	29,275	29,330
25,230	28,300	30,200
31,070	28,650	28,350

Routine tests taken from first, middle and last parts of seven consecutive ladles from the cupola. Machinable iron for light castings.

Table IV

Various High Strength Irons Poured in Regular Practice

No.	Carbon	Silicon	C+0.3 Si	Phos	Sulphur	Mang.	C.C.	Transverse Ten. Strength Diam. as Cast	Mod. of Rupt.	Pounds per Sq. in.	Brinell Number	Number of Bars	Diam. as Tested	Remarks	Authority
1	3.17	1.95	3.65	0.35	0.079	0.62	0.55	1.20	66,595	39,200	205	2	0.686		Bolton
2	3.18	1.87	3.74	0.31	0.078	0.63	0.56	1.00	79,005	40,780	207	3	0.686		Bolton
3	3.12	2.06	3.74	0.31	0.047	0.61	....	1.00	82,670	40,865	235	3	0.686	Ni-0.40%	Bolton
4	3.12	2.06	3.74	0.31	0.047	0.61	....	1.20	69,160	39,784	202	2	0.686	Ni-0.40%	Bolton
5	2.73	1.75	3.26	0.28	0.060	0.62	....	0.50	91,650	51,040	...	4	0.319	Ni-1.15%	Bolton
6	2.69	1.75	3.22	0.28	0.060	0.62	....	1.00	87,100	45,690	241	4	0.686	Ni-1.15%	Bolton
7	2.65	1.75	3.18	0.28	0.060	0.62	....	2.00	83,325	39,320	223	3	0.800	Ni-1.15%	Bolton
8	2.54	1.76	....	....	....	....	....	0.50	pulled as cast	79,475	364	2	0.500	White; Ni-20.0; Cr.-6.9	Bolton
9	1.64	0.88	1.91	....	....	....	....	0.50	pulled as cast	72,280	...	1	0.500	White; Ni-13.5; Cu.-5.75	Bolton
10		Same as No. 9 but annealed								58,420				Gray; Elong.- 4.8%	Bolton
11	3.10	1.48	3.54	0.09	0.056	0.32	1.45	0.80	94,700	41,990	240	2	0.64		Wust & Bardenheuer
12	3.10	1.48	3.54	0.09	0.056	0.32	1.54	0.60	80,600	41,600	251	2	0.48		Wust & Bardenheuer
13	2.92	1.43	3.35	0.11	0.072	0.37	1.15	1.00	78,250	40,650	235	2	0.80		Wust & Bardenheuer
14	2.92	1.43	3.35	0.11	0.072	0.37	1.28	0.80	81,550	41,975	239	2	0.64		Wust & Bardenheuer
15	2.92	1.43	3.35	0.11	0.072	0.37	1.30	0.60	81,600	40,400	250	2	0.48		Wust & Bardenheuer
16	3.14	1.49	3.59	0.10	0.088	0.37	1.35	1.00	77,400	41,350	235	2	0.80		Wust & Bardenheuer
17	3.14	1.49	3.59	0.10	0.088	0.37	1.36	0.80	75,950	38,190	236	2	0.64		Wust & Bardenheuer
18	3.14	1.49	3.59	0.10	0.088	0.37	1.41	0.60	68,525	41,350	247	2	0.48		Wust & Bardenheuer
19	3.01	2.25	3.68	0.03	0.019	0.33	0.70	1.181?	72,400	44,100	209	1	?		Vogl
20	2.82	2.13	3.46	0.03	0.017	0.28	0.78	1.181?	75,050	46,000	232	1	?		Vogl
21	2.90	2.22	3.57	0.03	0.016	0.29	0.79	1.181?	80,800	47,350	230	1	?		Vogl
22	3.05	1.66	3.54	0.03	0.008	0.34	0.67	1.181?	79,490	50,000	209	1	?		Vogl
23	3.06	1.67	3.55	0.03	0.008	0.33	0.64	1.181?	79,520	47,850	204	1	?		Vogl
24	2.85	2.14	3.49	0.03	0.005	1.04	0.71	1.181?	81,850	45,200	221	6	..		Wust & Meissner
25	3.04	1.46	3.48	0.06	0.010	1.12	0.74	1.181?	82,450	48,200	215	6	..		Wust & Meissner
26	2.70	1.66	3.20	0.40	0.076	0.93	....	1.181?	78,450	44,800	225	2	..		Wust
27	2.73	2.20	3.39	0.26	0.109	1.34	....	1.181?	83,760	52,100	240	8	0.787?		Corsalli
28	3.15	2.16	3.80	?	0.087	0.56	....	1.25?	70,350	41,990	....	6	?		Meissner

Nos. 1 to 7—Cupola iron and electric furnace, all gray irons. No. 8—Special alloy white iron.

Nos. 11 to 18—Tests at Meier & Weichelt on air furnace iron, mixed in crucible with ferrosilicon and ferromanganese. Nos. 19-23—All stee scrap recarburized in electric furnace. Note low phosphorus and sulphur. Nos. 24 and 25—Crucible melted. No. 26—Wust oil-fired cupola. No. 27—Note test bar. No. 28—Cupola semisteel.

one-fourth of this breaking strength is useful in resisting permanent deformation. The exact useful limiting load depends on the period of time of its application. On a test bar the elastic limit is established in a few seconds. In service the limiting load is lower than that determined by short time test because of the time factor. Creep or flow tests establish that load at which no flow or continuous stretch occurs, even over extended periods of time.

The cast iron curve is unusual in that it is curved almost from the beginning. We have assumed the variation negligible up to 0.001 inch strain. Thus it apparently has no well defined elastic limit, unless this be zero. By logic it might be concluded that cast iron, on long time loading, will break at extremely low stresses, as it at all times is beyond a proportional limit. Yet experience teaches that cast iron in service will stand stresses up to possibly 50 per cent of its strength for many years. The why and wherefore of this will be explained in a later section. It suffices to say that after several applications of load on cast iron, the material begins to follow Hookes law of proportionality of stress to strain much more closely.

The yield point or commercial elastic limit of the cast steel is high, somewhat over 50 per cent of its ultimate strength; its modulus of elasticity (that is the unit stress divided by the unit strain) being about 30,000,000 pounds. The stress strain curves shown are but partial, the iron and bronze curves going but little above the elastic limits. However, the *area* under the *complete* curve is a measure of the work (FS) required to rupture the material, and this in turn is held to be proportional to the impact resistance. The steel has 28.5 per cent elongation, the bronze 29 per cent compared to possibly 0.4 per cent for the iron. This explains the much better shock resistance of the two more ductile materials.

The appearances of the broken test bars also show these differences in ductility. Up to a certain point steel stretches uniformly. Then a part begins to stretch rapidly, to neck down or constrict locally and the piece soon fails. Bronze usually stretches rather uniformly over the whole gage length. Cast iron, however, shows no apparent deformation. It snaps off without necking and but slight general elongation.

In the ordinary stress-strain curve, various grades exhibit different moduli of elasticity as well as different ultimate tensile strengths. Fig. 24 shows stress-strain curves for several grades of cast iron all made and poured in a like manner. The stronger irons not only have a greater ultimate strength but also are stiffer and more rigid. In general, those factors promoting lower total carbon, a pearlitic or even sorbitic matrix, and small general grain size, produce stronger irons particularly in heavy sections.

Tensile strength also varies with the casting volume to area ratio or cooling rate. These effects for several grades of iron are shown in Fig. 19. Variations in tensile strength

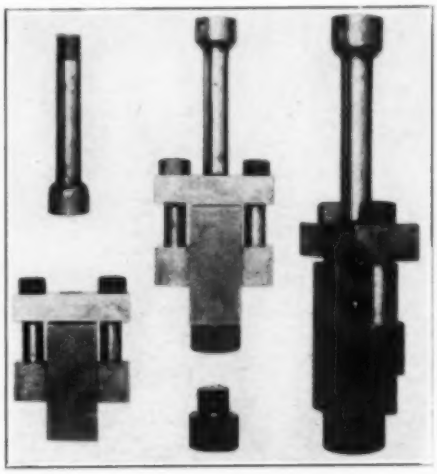


FIG. 25—VIEWS OF THE ROBERTSON SHACKLES SHOWING THE DIFFERENT PARTS

from day to day in ordinary foundry practice are shown in Table III. This table also shows variations in cupola operation under good control in one day's run. Analyses and tests of some typical high strength metals are shown in Table IV.

Pattern Designations Adopted by Industry

According to an announcement of the bureau of standards, a sufficient number of written acceptances have been received for the recommended commercial standard for foundry patterns of wood to warrant establishment as a commercial standard. It is effective immediately for new production.

The standard covers standard color markings for foundry patterns of wood to provide the molder with correct information regarding location of cores, surfaces to be machined and portions to be filled where stop off construction is used. Surfaces to be left unfinished are to be painted black; machined surfaces are to be painted red; seats of and for loose pieces are painted with red stripes on yellow background; core prints and seats for loose core prints are painted yellow and stop-offs are to

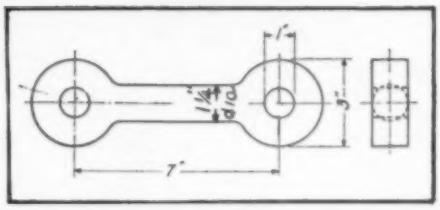


FIG. 26—BOEGEHOLD'S TEST SPECIMEN WHICH IS SUSPENDED BY THE EYE HOLES

be designated by diagonal black stripes on a yellow base.

Pattern manufacturers are free to use any quality paint, varnish or shellac as desired and a considerable variation in shades of colors is permitted. Recommended colors may be obtained by mixing suitable inexpensive pigments with shellac.

A. S. M. E. Celebrates Its Fiftieth Anniversary

The American Society of Mechanical Engineers will celebrate its fiftieth anniversary on April 5 to 9 in Washington, Hoboken and New York. The festivities will begin in New York, April 5, when the guests will register at the United Engineering Societies building, 29 West Thirty-ninth street. That will be followed by the unveiling of a tablet in the lobby of the building commemorating the anniversary.

The program will be continued at the Stevens institute, Hoboken, N. J., where a colorful pageant will be presented. The Metropolitan section of the society will give a welcoming dinner at 7:30 p.m. at the Hotel Roosevelt, New York, at which Charles M. Schwab, a past president and honorary member will act as toastmaster.

On Sunday morning commemorative services will be held at the Cathedral of St. John the Divine, New York. Following the services the guests will depart for Washington where on Monday morning, April 7, a welcoming meeting in the national council chamber of the United States chamber of commerce will be addressed by a representative of the government, Charles Piez, president of the society, delegates from foreign countries and presidents of the various engineering societies. Palmer C. Ricketts, president of Rensselaer Polytechnic institute, and William Butterworth, president of the chamber of commerce of the United States, also will deliver addresses in behalf of the American educational institutions and business organizations respectively. The afternoon will be devoted to the presentation of papers on the humanizing of aspects of engineering, followed by a reception at the White House.

Hot Iron Obtained
By Economical Cupola Operation

Best Results Depend on Maintaining the Correct Bed Height and the Right Amount of Air—Eliminate Flame at Charging Door

By H. V. Crawford

ORDINARILY the first consideration in cupola practice is to secure hot iron, but experience has shown that the iron can be hot and still not be of the proper mixture, or it can be hot and still not hold its heat. Therefore, it may freeze quickly and by the time it is ready to pour be entirely unfit for pouring. The difficulty may be due either to an improper mixture to begin with, or too much air burning out the coke, lowering the bed and burning the iron. Too much air not only changes the analysis, but affects the fluidity of the iron and the strength of the resulting casting. Observation of the temperatures by the naked eye or by pyrometer usually will indicate whether or not the iron is hot enough. Probably a better check is to pour samples into a fluidity test mold using iron from a ladle just before pouring takes place.

Gives Main Factors

Best results in cupola melting depends on: Starting with right bed; maintaining right bed; starting with right amount of air and maintaining right amount of air. Efficient operation is indicated by the elimination of practically all of the flame at the charging door, with only warm gray smoke rolling up when the total charge is 12 to 15 feet deep.

The blower should supply air to only one cupola at a time, and in case it is used to supply air to one cupola on one day and a different cupola on the next day, it should be large enough for the large cupola and should be run at a lower rating on the smaller cupola. The piping in this case should have hand gates of the damper type to direct the flow of air into either cupola as desired. The damper type gates such as made by the General Electric Co., Schenectady, N. Y., are practically air-tight. Gates of this type should be used instead of the ordinary slide gate which may permit a large amount of air to leak out. An ordinary slide gate 2 feet wide may have a leakage from 500 to 700 cubic feet per minute.

The following tabulation gives the amount of air in pounds recommended for different iron to coke ratios. These values are based on using good coke of around 88 per cent fixed carbon and take into account approximately 5 per cent air leakage.

Ratio	Pounds Per Minute
12 to 1	25.3
11 to 1	26.0
10 to 1	26.8
9 to 1	27.8
8 to 1	29.0
7 to 1	30.6

The 5 per cent excess air allows for all leakage of air through the slag hole, extra gates, tuyeres, peep hole covers, up the inside lining of the cupola and up between the shell and brick lining of the cupola, and also through any leaks in the pipe line.

The tuyere peep hole covers should be made as air-tight as possible and preferably a casting should be used which has a groove filled with packing to fit over the edges of the openings. Also, the plates forming the top of the tuyere should be fitted in and the cracks filled to prevent leakage of air up the cupola between the shell and the brick lining. If the leakage is greater than 5 per cent more air than that given in the tabulation will be required.

The tendency in the past has been to use far too much air, and experience indicates that less air can be used with equally good results. With a high coke ratio and the right amount of air, more efficient operation can be secured with a saving in coke and at the same time, consistently good hot iron can be melted at a faster melting rate.

It is necessary to do some experimenting to arrive at the best operating conditions in each case, and, therefore, it is recommended that a definite record be kept from day to day. Each day's run that shows improvement should be duplicated to make sure that no other variable has crept in and caused the change indicated by the data.

Assuming, for a certain size cupola, that the blower is started with the bed well-lighted and of the proper height to get the best operating conditions. That the charges of iron and coke are of the proper weight, but that the air is low. The low air condition means that less carbon will be burned to CO, and more to CO in a given time. Therefore, the melting rate will be low, but the iron should be hot providing the iron to coke ratio is high, preventing the bed from being built up higher. If the ratio is low, more coke will be in the bed and more of the heat will be used bringing this additional coke up to incandescence.

May Cause Oxidation

Increasing the amount of air supplies oxygen at a faster rate and more carbon is burned in a given time and better results up to a certain extent will be secured. However, when the air is increased, and, therefore, oxygen is carried up farther in the bed, it may reach the melting zone and the iron will be oxidized. Also, more heat units are absorbed by the additional nitrogen and, on account of the increase in the speed of the blast, sufficient time is not allowed for the nitrogen to give up sufficient heat to the iron so that the heat is carried out the stack. High air flow also means high wind-box pressure.

Construction of the tuyeres should be such that the air is distributed evenly around the cupola. They should also have the proper height to give enough velocity to the amount of air required so that the air will penetrate into the center of the cupola. Tuyeres should be continuous and should have a height from two to six inches. The smaller the height the higher velocity of a given amount of air, and therefore, the better penetration. Changing the height has no appreciable effect on the wind box pressure for a given amount of air, as the length of the path the air has to travel, passing through the tuyeres, is short. Five

inch tuyeres on a 54-inch inside diameter cupola have been bricked down to 2-inch height and no effect on either the operation of the cupola, wind box pressure, or the cutting of the lining could be determined.

Changing the size of the tuyeres generally is supposed to affect the speed of the blast, and for the correct amount of air, varying the height of the tuyere will affect the speed of the air entering the cupola, as previously explained, but the speed of the blast is the amount of air passing through the bed divided by the area of the cupola across the bed. For a given area the speed of the blast will be affected only by the amount of air being used.

The plate forming top of the tuyere should come to within one or two inches of the inside of the lining with the lining perfectly straight up and down, and the plates forming the bottom of the tuyere should be about eight inches greater in diameter than the top plate on the inside. This makes the reservoir 8 inches larger in diameter than the shaft, and probably eliminates any question regarding the desirability of having a bosh or pinch in the cupola just above the tuyeres.

Use One Tuyere Row

This method of construction reduces the possibility of iron or slag running or splashing into the tuyeres. Also, the stream of iron and slag is farther away from the cold air just entering and allows the air to be heated to some extent before it strikes the melted iron and slag. It is assumed that no upper tuyeres are being used, as it has been determined that they are not only unnecessary, but also require an increase in the height of the bed by an amount equal to the distance between the tops of the lower and upper tuyeres.

The function of the bed is to develop a sufficient number of heat units to melt a definite amount of good hot iron in a given time with a minimum of waste heat. Therefore, a certain amount of incandescent coke will require a certain amount of oxygen in a given time to burn the maximum amount of carbon in the fuel to CO_2 gas and a minimum amount to CO gas, thereby obtaining the best efficiency. Each pound of carbon burned to CO_2 gives three times as much heat as every pound burned to CO. Therefore, the bed of the cupola should be operated the same as the bed of fire in any furnace, burning the proper amount of fuel and the correct amount of air at all times. Thereby more heat per pound of fuel will be secured and the heat will be utilized for the purpose for which it is generated instead of forcing it out of the stack.

The kind of fuel used in igniting the bed is unimportant, just as long as the bed is well-lighted throughout and is thoroughly incandescent in front of the tuyeres. In some foundries square holes the size of a couple of bricks placed on edge and lengthwise in the lining are used to allow a better draft in the wood or to allow the use of oil or gas burners. These holes are filled with fire brick as soon as the bed is lighted thoroughly.

Measure Coke Bed

With the cupola lined up approximately the same each day, the amount of coke in the bed can be determined best by measuring from the charging door. After the bed is burned through, red all over, the coke shows red through all the tuyere openings, about 6 to 10 inches of coke should be added to bring the height of bed up to approximately 20 to 30 inches above the top of the tuyeres. The tuyere openings then should be closed to prevent the bed from burning out excessively and starting the cupola with too low a bed. In starting with a 20 to 30 inch bed it is intended that this is really the height of the bed when the wind is turned on. If the bed is much over 30 inches in height, it will probably not be possible to get the best operating conditions.

The coke bed is of the utmost importance and, unless it is lighted properly, started at the right height, and maintained at this height throughout the entire run, it will be impossible to get the best and most consistent results. The coke charges should be uniform in volume or weight from start to finish and should be level in each charge. If the coke is stored in the open, it is necessary to charge by volume, checking the volume by weight of dry coke at frequent intervals. Baskets or boxes should be used as they will give more consistent charging than the use of an ordinary coke fork. It is much preferable to store the coke in a dry place and to use scales for weighing each charge.

Increase Iron Ratio

The weight of the coke charges depends on the weight of the iron charges. Starting with a 10 to 1 ratio of iron to coke between charges, this ratio can be increased and less coke charged each day. As a result a much higher ratio gradually can be secured. Experience leads to the belief that at least a 10 to 1 ratio, exclusive of bed, can be secured readily and, with a few tests, ratios of from 12 to 14 to 1 can be secured. A number of foundries now are running with ratios this high and are melting hot iron rapidly.

The iron charges should be uniform in weight from beginning to end, should be level in each charge and the weight should vary depending on the inside lining diameter. Roughly, the weight should vary from 1000 to 4000 pounds per charge, using 1000 to 1500 pound charges up to 42 inches diameter; 1500 to 2000 pound charges from 42 up to 54 inches, and 2000 to 4000 pound charges from 54 inches up.

Ordinary limestone, except in rare cases, is satisfactory for flux charges, and the amount of charge should vary from 1 to 3 per cent, depending on the amount of scrap and the conditions of the material charged into the cupola. Enough should be charged to keep the slag running freely, as it is necessary to remove the slag as fast as it is formed to keep the cupola in the best of operating conditions.

Control Is Automatic

Increasing the height of the charging door will give the gases a better chance to give up their heat to the descending iron charges, but at the same time causes more coke in the upper charges to be burned before reaching the bed. Also, there will be more lining to be heated and, therefore, greater radiation. Therefore, having the charging door over 15 feet above the bottom, probably will not improve the efficiency to any great degree. Also, higher charges mean higher pressure, to force the gases through the additional resistance.

While the previously mentioned factors bear directly on the operation of any cupola, they will be considered specifically in the operation of a cupola equipped with an automatic blower control developed by the General Electric Co., Schenectady, N. Y. To determine the best operating conditions with this device it is recommended that the first trial runs on the cupola be on the basis of a 30-inch bed, 10 to 1 ratio between charges, and 26.8 pounds of air per minute per ton of iron per hour. This is on the basis of using good coke with no leakage of air in the pipe line or gates and with normal leakage around the wind box and tuyeres.

The iron should come hot and at the normal rating of the cupola. The cupola then should be run on this basis for a few days to make sure that satisfactory operation can be secured under these conditions. The amount of coke then should be reduced to give a ratio of 10.5 to 1 and the air reduced to 26.4 pounds of air per minute per ton per hour. If results are satisfactory after two or three days, an 11 to 1 ratio should be used and 26.0

pounds of air; then 11.5 to 1 and 25.6 pounds, and then 12 to 1 and 25.3 pounds of air. Beyond this point practically no change in the air will be necessary and further improvements will come from reducing the coke charges and possibly the bed. On starting with a 10 to 1 ratio it may be found that the iron is cold or cools quickly. This indicates that the bed probably burned out too much at the start. A double charge of coke should be put in and the air reduced until this charge reaches the bed. When the iron is coming cold or burnt, a remedy in the past has been to add more coke, but cutting the air will eliminate the difficulty, although the melting rate may be lowered. Using too much coke or too little air is playing safe, and with the automatic control giving a constant weight of oxygen at all times, consistent results can be secured day in and day out. By working for a balance of bed, coke charges and oxygen, a great improvement in the coke ratio can be made.

Iron Melts Too Slow

It also may be found that the iron is melting too slow. This indicates that the bed is probably too high at start. The air should be increased considerably and held long enough to burn out the bed. It also may mean that the air leakage is too great and should be reduced or the amount of air increased. Slow melting means too much coke in the bed and in the charges, or not enough air, and it means that the iron is being melted with CO instead of CO_2 gas. By reducing the coke, good hot iron will be secured and the melting rate can be increased. In one case it was stated that the cupola was only melting 12 tons per hour. It was discovered that the blower had been shut down 24 times during the 10-hour run and, taking out the time the blower was shut down, the melting rate was 16.5 tons per hour. In spite of all the shut-downs, the iron was hot all day long and one shut-down was for 50 minutes.

Under good operating conditions, the maximum tonnage rating of cupolas as specified by the manufacturer can be obtained and, under the best operating conditions, the maximum rating can be exceeded.

When the maximum rating gives the iron entirely too fast, the cupola should be lined down to give the proper rate to secure the best efficiency. If, however, the rate is somewhere near right, the cupola can be operated entirely satisfactorily by shutting the blower down and stopping the melting. Taking out the time the blower is shut down will give the proper melting rate, but in any given hour the number of tons melted will depend on the percentage of time the blower is operating. When the blower is shut down, the slag should be running, thus indicating that the reservoir is full of iron, and the tap hole should be bodded up. The cupola then can stand from 30 to 45 minutes and, on starting again, the iron should be as hot as before as but little heat is lost if the iron is kept inside the cupola. Holding the hot iron keeps the cupola in good condition and no effect in the cupola operation should be noticed.

In case it is necessary to start with a low ratio and possibly a high bed, working up gradually, the first step of course is to have the proper mixture of iron. Since a high amount of air, although it may give a high melting rate, may affect the chemical analysis, temperature, freezing point, and strength of the iron, it is much better to start with a small amount of air as given in the tabulation and gradually cut the coke down in the charges and the bed as long as improvement in the operation is secured.

Pressure Should Be Low

High wind box pressure indicates too high an amount of air bridging around the tuyeres. With the right amount of air the wind box pressure should not be over 16 ounces. The air should be reduced and the tuyeres should be built as previously described. Also the iron in the reservoir should be kept near the tuyeres and the slag kept running at all times. The hot iron being nearer the tuyeres, keeps the region around the tuyeres hotter and keeps the cold slag and iron at this point from building up into a cold ring.

Excessive use of brick is caused by the amount of air being too high. A lower amount of air will decrease the number of bricks used and the amount of work necessary to fix up the cupola each day. Slag hole burning out is caused by excess air, resulting in a high wind box pressure and not keeping the iron high enough in the reservoir to keep the slag running all the time.

Melts Steel in Electric Furnace

By R. N. Blakeslee

IN JANUARY, 1927, the pioneer foundry installation of high frequency, coreless induction furnaces manufactured by the Ajax Electrothermic Corp., Trenton, N. J., was made at the Beaver Falls, Pa., plant of the Babcock & Wilcox Tube Co. This equipment now has been in daily production for several years and the results and experiences obtained are interesting. Metals usually melted are heat, chemical and abrasion resisting type which require pouring temperatures between 2900 and 3200 degrees Fahr. High speed steel and other alloys are made occasionally. The average daily production of the foundry is 4000 pounds per 9-hour day, although frequently this is increased to 8000 pounds by running two shifts.

In a series of 25 consecutive heats of an alloy containing 28 per cent chromium, 8 per cent nickel and 0.50 per cent carbon, the variation in chromium was not over 1½ per cent between high and low; nickel did not vary 0.75 per cent between high and low, and all carbons were within 0.06 per cent. The series of heats was made from miscellaneous scrap only. Some of the different alloys which are melted in the furnaces are given in Table I.

A typical result obtained with analysis of scrap charged and final analysis is as follows:

	Analysis Metal Charged	
19.60 Cr.	8.6 Ni	0.213 C
	Analysis Metal Poured	
18.00 Cr	8.96 Ni	0.19 C
Size pour		300 pounds
Crucible-Acid		Heat 156

The log which follows shows the meter readings, etc., during a typical 1000 pound melt of a 22 per cent chromium, 23 per cent nickel alloy:

Time Min.	Generator Volts	Generator Amps.	Generator K. W.
0	900	200	175
5	1000	182	175
20	1000	175	175
35	970	185	175
50	900	200	175
65	940	200	175
80	900	200	175
95	900	200	175
110	900	200	175
120		Poured	

Pouring temperature 2900 degrees Fahr. minimum. Time to melt, two hours. Kilowatt hours measured at input to motor, 490. Kilowatt hours per 2000 pounds, 980.

Average kilowatt-hour consumption per ton on the various alloys runs approximately 950 in the 1000-pound furnaces and 850 in the 400-pound furnaces. These figures are measured at input to motor and include power

used to hold temperatures constant during the pouring period. When high speed steel ingots are poured, some installations have shown as low as 660 kilowatt-hour consumption for 2000 pounds.

Metals usually are melted in acid linings which produce about 200 heats before they are replaced. The 4-furnace equipment, of which only one furnace operates at a time, gives excellent means for keeping the production of the shop up to normal. The spare furnace in each size permits repairs to refractories without interruption of the melting schedule.

The furnaces are energized by high frequency current supplied by a motor generator set. The motor driving the generator is a synchronous motor rated at 250 horsepower, 2200 volts, 3 phase, 60 cycles. The generator is single phase and is rated 150 kilowatts. The motor generator set with starting switch, condensers, etc., is housed in a room which is closed off from the foundry proper, but is adjacent and under the same roof. Ventilation is provided to prevent overheating, and the room is kept free from dirt and fumes.

Has Duplicate Furnace Units

The generator control panel, which with condenser controls, regulates the furnace production, is mounted in the wall of the generator room. The panel with meters and switches faces the furnaces, and the operator has but a few steps to go from his furnace to the controls.

Four furnace units, two of them holding 400-pound charges and two holding 1000-pound charges, as shown in the accompanying illustration, are mounted in a row about 6 feet from the generator room wall. Switches are provided so that any one of the four furnaces can be thrown into service in a few seconds. All four furnaces are of the type which tilt around the spout and are tilted by means of an electric hoist, operating on an I-beam over the back of the furnaces but well above them to give ample head room.

Metal is poured from furnace into ladles which have been preheated with oil and from the ladles into the molds. When small molds are poured, and the time for pouring off the heat extends over several minutes, a small amount of power is turned on the furnace to maintain a constant temperature.

Table I

Analyses and Data on Alloys Melted

Chromium	Nickel	Carbon	
18.80	9.0	0.20	Heat and corrosion
25.0	10.0	1.15	Abrasion resistant and tools for hot work
18.0		0.25	Corrosion resistant
16-20	65-70	0.50	Heat resisting
22.0	23.0	0.40	Heat resisting
28.0	6.0	0.40	Heat resisting

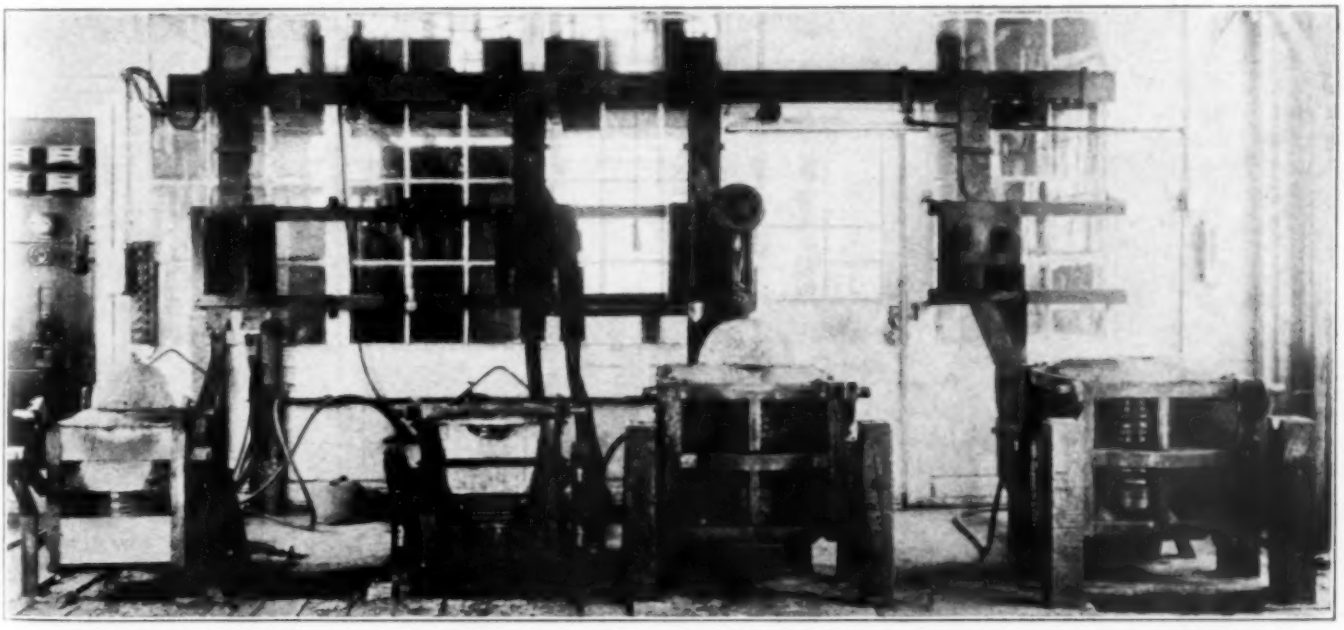
High-speed steel and various other alloys.

Publish Safety Folders

National Safety council, 20 North Wacker drive, Chicago, has issued a series of bulletins on safety methods. These include Nos. 11, 27, 50 and 76 and deal respectively with floors and floorings; drinking water, wash and locker rooms and toilet facilities; and practical methods of reducing fatigue. The first folder is devoted to the requirements of a good floor, its maintenance, flooring materials and those recommended for various installations. The second shows layouts for wash and locker rooms as well as many views of the different types of apparatus used. The third comments of the methods that are available for reducing the fatigue of workers of various types. The other bulletin is devoted to information on the uses and hazards of portable electric tools.

H. H. Porter Re-elected

H. Hobart Porter has been re-elected chairman of the Engineering Foundation, 29 West Thirty-ninth street, New York, research organization of the national societies of civil, mechanical, mining, metallurgical and electrical engineers. The foundation, under the leadership of Alva C. Dinkey, president, The Midvale Co., Nicetown, Philadelphia, and with the co-operation of the American Iron and Steel institute, has raised a fund to finance the initial stage of a program of co-operative research in alloys of iron. Subscriptions in excess of $200,000 have been received.



TWO 400-POUND FURNACES ARE LOCATED AT THE LEFT, AND TWO 1000-POUND FURNACES ARE AT THE RIGHT

Fig. 1—Pouring cast iron pipe in a pit

PIPE *Is Held* To Close Limits

By Pat Dwyer

WHILE not exactly infallible as an evidence of prosperity, a rapid increase in population in any given locality conveys to the average person the impression that business is better than usual and that large amounts of money are in circulation. A list of manufacturing establishments is impressive and a tabulation of bank clearings over a given period is interesting to men with financial training and experience. The significance of figures of that kind is not grasped readily by the ordinary reader.

He has not the inclination, the necessary training or the breadth of vision to analyze these figures and thus gain a true perspective.

When he reads that the population of a given community has doubled, trebled or quadrupled in a certain definite period, the mental impression is sharp and vivid. Without any conscious effort, without the necessity of attempting to visualize the myriad details, he instinctively realizes that the place must be a hustling, progressive community through which the financial life blood circulates generously and freely.

When the Howard, Harrison Iron Co., St. Louis, erected the first pipe plant in the Birmingham district in 1889, the population of Birmingham was 26,198. In the years that followed, dozens of other manufacturing plants, including that of the Tennessee Coal, Iron & Railroad Co., were established. In the 20-year period between 1890 and 1910 the population increased to 132,685. Although not quite in the same proportion, the phenomenal increase has been maintained up to the present. The census report for 1925 gives the population of Birmingham as 237,693 and a local survey for 1930 estimates the population at close to 300,000. Low priced iron and low priced labor was the combined magnet which induced the Howard, Harrison Iron Co., to erect a pipe plant in this district. The limited supply of lean ore was one of the principal factors underlying the decision of the Tennessee Coal, Iron & Railroad Co., to transport its plant from South Pittsburg, Tenn., to this paradise of natural resources.

FIG. 2—MAP SHOWS LOCATION OF MOLDING SAND DEPOSITS AND PIPE SHOPS

Jones valley, extending east and west is bounded on the south by a practically inexhaustible mountain of iron ore. The mountain on the north contains an equal amount of coal and the floor of the valley is paved with limestone.

United States geologic surveys—open for the inspection of any interested person—have estimated the extent of these natural resources at so many billion tons, but for all practical purposes, perhaps it is sufficient to say that the supply is ample to keep the blast furnaces of Birmingham roaring until mankind—if ever—finds a suitable substitute for iron.

It is not unreasonable to expect that ore will be pouring in at the top and dazzling white iron will be cascading from the breasts of these furnaces in the dim and distant future when the late Mr. Macauley's well known traveler from far away New Zealand stands on a broken arch of London bridge and gazes pensively on the few remaining ruins of St. Paul's cathedral.

Reference to pig iron is pertinent

FIG. 3—STATUE OF VULCAN MADE IN BIRMINGHAM FOR EXHIBITION AT THE LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, 1904

FIG. 4—PRACTICALLY ALL THE PIPE PITS IN RECENT YEARS ARE ARRANGED FOR POURING THE PIPES IN A STRAIGHT ROW INSTEAD OF THE FORMER CIRCLE. FIG. 5—THE 18-FOOT CENTRIFUGALLY CAST PIPE ARE DIPPED IN A PITCH BATH ON A SPECIAL DEVICE WHICH HOLDS TWELVE

at this point because the cost of pig iron is the greatest single factor in the production cost of cast iron pipe. Beginning on a small scale the production of pig iron in the Birmingham district increased to a point where it came to be recognized as the dictator of pig iron prices throughout the country. In like manner the price of southern pipe made from southern iron, affected the selling price of all pipe made in the North. Tables I and II indicate the fluctuation of prices for pig iron and cast iron pipe over a considerable period. The 24 blast furnaces in the Birmingham district have a combined annual capacity of 3,000,000 tons. Of this amount approximately 50 per cent is converted into steel, 25 per cent enters the pipe shop and the foundries and 25 per cent is shipped outside.

Recent resignation of George Gordon Crawford, for the past 30 years president of the Tennessee Coal, Iron & Railroad Co., a subsidiary since 1907 of the United States Steel Corp., to accept the presidency of the Jones & Laughlin Steel Co., Pittsburgh, will recall to old time iron and steel men many newspaper stories current at the time of the merger.

These stories radiated prosperity and good cheer for the present and even brighter prospects for the future. Some of the more enthusiastic writers boldly declared that the famous Star of Empire definitely had changed its course. Instead of heading due west as per long established schedule, it now was traveling directly south and was blazing with increasing brilliance as it neared the Birmingham district. Some of these stories were so permeated with financial statistics that small country weeklies invariably ran out of $ signs and had to run the stories in sections in succeeding weekly issues. Money, formerly a shy and retiring object of worship to the few, was beginning to come out of its hiding place. The common people actually enjoyed glimpses of it occasionally.

John W. Gates, "Bet-a-Million-Gates," visited Birmingham during the United States Steel Corp., negotiations and was treated with proverbial southern hospitality. A group of local men pooled a fund of $30,000 to finance a little game of poker to which he was to be invited as the guest of honor. Now $30,000 is only $30,000 and it does not look so impressive now as it did back in 1907 when, according to present valuation standards, it was equivalent to approximately $90,000. One of the group informed J. W., that they expected to give him a run for his money.

"How much you got?" the great plunger inquired carelessly.

When he was told that $30,000 was waiting for him if he could take it away, he said he never played cards for a trifling stake like that.

He fished a half dollar from his pocket and held it between his palms. "Here," he said, "I'll match you for it, one flop!"

Decidedly the city was growing up and developing into an important industrial and financial center. The vision and faith of the first pipemaker were more than fulfilled. Busi-

FIG. 6—A WELL EQUIPPED MACHINE SHOP FOR EFFECTING REPAIRS AND REPLACEMENTS, IS AN INTEGRAL PART OF A LARGE PIPE PLANT. FIG. 7—THE CLEANING ROOM FOR MISCELLANEOUS SMALL FITTINGS PRACTICALLY IS OUTSIDE

Table I

Pig Iron Prices Over a Period of 16 Years

January	Basic Valley	No. 2 Foundry f.o.b. Valley	No. 2 Foundry f.o.b. Chicago	Southern No. 2 f.o.b. Birmingham	No. 2X Delivered Phila.	Southern Ohio No. 2 f.o.b. Ironton	No. 2X f.o.b. Virginia Furnace	No. 2X Foundry f.o.b. Buffalo
1929.....	$17.50	$17.50	$20.00	$16.50	$22.26	$18.50	$21.25	$19.00
1928.....	17.00	17.25	18.50	16.00	20.51	19.00	20.50	17.50
1927.....	18.50	18.43	20.90	18.50	22.76	19.90	21.75	19.75
1926.....	20.00	20.50	23.00	22.75	24.26	21.40	23.50	21.50
1925.....	21.90	22.25	23.80	20.10	25.61	22.00	24.50	23.50
1924.....	21.40	22.40	23.70	21.60	24.26	22.90	25.00	25.10
1923.....	25.90	27.00	28.80	23.30	29.56	27.90	27.50	28.00
1922.....	18.30	20.05	19.00	16.15	21.55	19.60	21.75	19.80
1921.....	29.35	31.10	32.75	33.75	35.00	34.60	34.50	33.75
1920.....	38.20	40.90	40.00	38.20	43.90	39.50	41.25	41.50
1919.....	30.00	31.00	31.00	31.00	36.15	31.00	35.25	32.25
1918.....	33.00	33.00	33.00	33.50	34.25	33.00	33.50	33.50
1917.....	30.00	32.35	30.00	23.00	30.50	30.00	26.50	35.00
1916.....	17.85	18.90	18.50	14.50	19.75	18.30	17.25	18.50
1915.....	12.50	13.25	13.00	9.50	14.25	12.75	12.50	13.15
1914.....	12.35	12.89	14.25	10.50	14.75	13.00	12.75	13.00
1913.....	16.45	17.50	18.00	13.70	18.25	17.90	16.00	17.25

ness conditions, markets and even the mental outlook of the manufacturers were in a constant and healthy state of expansion.

Pessimists had said in the beginning that no further pipe plants were needed. That the freight rates from the south to almost any point where pipe was needed in large quantity would more than offset any saving effected in the price of labor and raw materials. They said that skilled men would not go south to work and that negroes never could be trained to work in industrial establishments. They claimed that the railroad service was so inadequate, customers would become impatient and would cancel contracts. They claimed that cast iron pipe, unlike many other forms of supply and equipment, lasted practically forever, and therefore, orders for spare parts and replacements, practically were negligible. Once a community was served, why, it was served. The producer constantly had to seek new fields. In a word and to be brief, they said plenty, but the peculiar feature is that they missed their guess on every point. The reason so many prophets are without honor in their own country is because so many of their prophesies fall flat. If the average man's memory was a little better than it is, the percentage of successful prophets probably would be even lower than it is at present.

Analyze Conditions

Men who claim that no further pipe plants were needed, failed to take two important factors into consideration. One was the rapidly increasing population of these United States and the other was a steady shift from a rural to an urban form of existence. The greatest gains in population have been noted in the cities. Rural communities might continue to make shift with the old oaken bucket, but the cities depend altogether on water delivered through suitable mains. Also, where one set of pipes is required for delivering the water, a second set is required for its discharge after it has served its purpose and is of no further use.

Table II

Cast Iron Pipe Prices

(6 inch and larger)

January	New York	Chicago	Birmingham
1929	$38.85	$45.20	$37.00
1928	37.15	36.20	29.00
1927	49.50	45.70	36.00
1926	51.50	48.70	42.00
1925	61.05	49.00	40.00
1924	66.10	56.00	46.80
1923	56.50	51.20	43.00
1922	47.30	41.60	35.00
1921	63.30	64.10	55.00
1920	67.30	67.55	60.00
1919	66.20	64.30	58.75
1918	55.35	54.30	49.00
1917	41.50	41.00	36.00
1916	29.00	29.20	24.00
1915	20.00	23.40	19.50

Large industrial establishments, located almost without exception in towns and cities, consume immense volumes of water. The innate prodigality of the human race to waste what comes easily is responsible for the fact that the average householder wastes more water than he uses. Where the water is pumped and then laboriously carried in pails, consumption is held to a minimum. Where an unlimited supply can be secured by simply turning a tap, the converse is true. Water used in industrial establishments and water wasted in households, account for a per capita daily consumption of 190 gallons in Chicago, 220 gallons in Philadelphia and correspondingly large amounts in every other large city.

The freight rate constituted the most serious of the many objections advanced, particularly in regard to the northern market. This is offset to some extent by low water borne freight rates to Pacific coast points. Pipe from Birmingham are shipped through the port of Mobile and thence via the Panama canal.

Low Water Rates

In this connection it is interesting to note that foreign competition is based to a certain extent on low ocean freight rates. It is claimed that the freight on a recent shipment of French pipe sent through the St. Lawrence, the lakes and landed in Detroit was $7 per ton. The freight from Birmingham, all rail is $7.90 a ton. The almost incredibly low wages and the price of pig iron prevailing in France, present another heavy competitive factor. It is claimed that the labor cost per ton of pipe is $1.06 while pig iron is

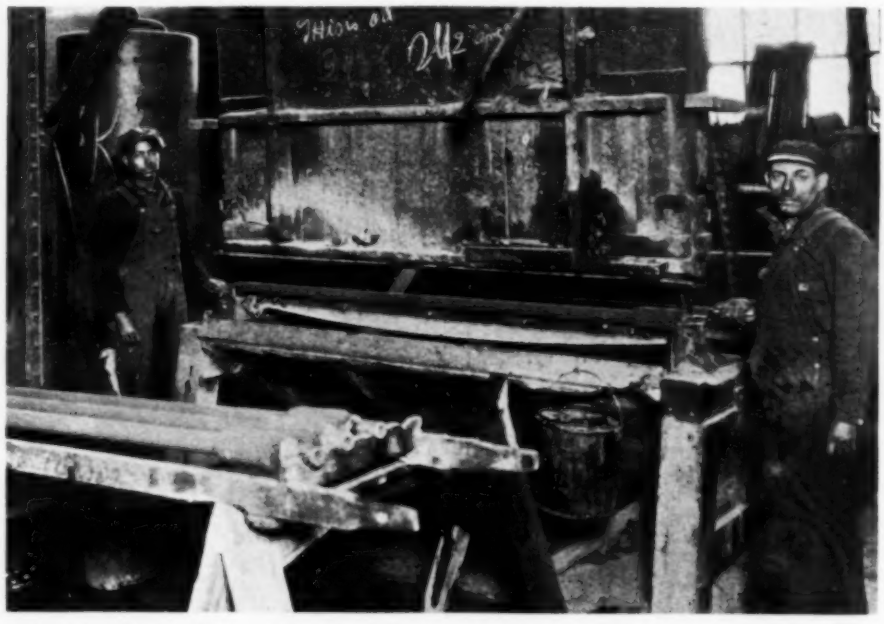


FIG. 8—GREEN SAND CORES FOR SOIL PIPE AND FOR CERTAIN TYPES OF SMALL PRESSURE PIPE ARE MADE ON THIS TYPE OF DEVICE

quoted at $9 per ton. Corresponding figures in southern pipe shops are $3.46 and $14. Railroad mileage from Birmingham to many of the principal distributing points is shown in the accompanying table. The reader who may be a little shaky on his geography probably will be astonished to find that Birmingham is closer to Chicago by almost 200 miles than it is to Pittsburgh.

A combination of patriotism and an ad valorem duty of 30 per cent has helped to limit the importation of French made cast iron pipe. During the past year the total tonnage imported amounted to between 60,000 and 75,000 tons. According to newspaper reports the Pont-A-Mousson Co., which operates plants in Pont-A-Mousson, Auboue, Foug, Saint-Etienne du Rouvray, Belleville, Sens and Toulouse in France, is contemplating the erection of a plant in Boston. Opinion at the moment is divided on the possible effect of this contemplated competition. Irrespective of who establishes a plant, it is plausible to assume that manufacturing costs will be on a par with those of existing plants in any given locality.

Secured Skilled Men

The prophesied bugaboo of inducing skilled men from the north to operate southern pipe shops failed to materialize. With the exception of a few notable men, originally from north of the Mason and Dixon line, the entire personnel, operative, executive and supervisory, has been recruited from the southern states.

Manufacture of cast iron pipe essentially is a system of mass production. Heavy and expensive equipment is required thus involving a large initial investment. Under present conditions this section of the industrial field is open only to companies with extensive financial resources.

The industry is highly competitive and this feature has been responsible for the installation of the most modern and efficient equipment and methods. Cast iron pipe today is manufactured more cheaply than any other foundry product which has to conform to engineering specifications.

Table III

Men and Wages Paid

Materials	Men	Money
Pig iron	16,250	$19,000,000
Coal, coke, limestone	1,700	3,800,000
Sand, coatings, paper and excelsior	1,700	3,000,000
Cement	65	130,000
Mill supplies	3,250	6,500,000
Power	650	1,350,000
Freight	7,000	13,500,000
Installation	17,000	34,000,000
Lead and jute	2,600	6,000,000
Valves and meters	25,000	27,000,000
Totals	75,215	$114,280,000

Mass production insures a uniform product.

Mass production is based upon standardization of men, materials, methods and equipment. Where every unit in a 1000-ton shipment, for example, must resemble each other even more closely than the proverbial peas in a pod, it is apparent that every factor affecting the castings must be under complete and accurate control. Extent to which the variable human factor enters the equation must be held to an absolute minimum.

Table IV

Mileage from City

FROM BIRMINGHAM

City	Miles	City	Miles
Atlanta	168	Cairo, Ill.	355
Chicago	637	Cincinnati	481
Columbus, O.	697	Indianapolis	499
Louisville, Ky.	405	Memphis, Tenn.	251
Mobile, Ala.	276	Nashville, Tenn.	205
New Orleans	355	New York	998
Pensacola, Fla.	259	Pittsburgh	821
Savannah, Ga.	430	St. Louis	486
Vicksburg	293		

Severe Specifications

Under the heading *Allowable variations in diameter of pipes and sockets*, Section 2 of the American Water Works association standard specifications for cast iron pipes and fittings reads:

Especial care shall be taken to have the sockets of the required size. The sockets and spigots will be tested by circular gages and no pipe will be received which is defective in joint room from any cause. The diameters of the sockets and the outside diameters of the spigot ends of the pipes shall not vary from the standard dimensions more than 0.06 of an inch for pipes 16 inches or less in diameter; 0.08 of an inch for 18-inch, 20-inch and 24-inch pipes; 0.10 of an inch for 30-inch, 36-inch and 42-inch pipes; 0.12 of an inch for 48-inch and 0.15 of an inch for 54-inch and 60-inch pipes.

Even men outside the industry can realize the high degree of skill and knowledge required to produce large castings inside these microscopic tolerances. Foundrymen accustomed to the vagaries of shrinkage, hydrostatic pressure, resistance of cores and the yielding of sand, will claim frankly that the production of a dozen duplicate castings showing no more than 1/16-inch variation in the diameter of a true 16-inch circle is outside the possibility of practical accomplishment. Pipe men turn out these castings day after day by the thousand, with unfailing regularity and as matter of course. The manufacture of cast iron pipe probably represents the highest development of the art and practice of founding in metals.

As if the foregoing specification was not severe enough, the thickness of metal in the pipe is limited rigidly. Section 3 of the same specifications, *Allowable Variation in Thickness* reads:

For pipe whose standard thickness

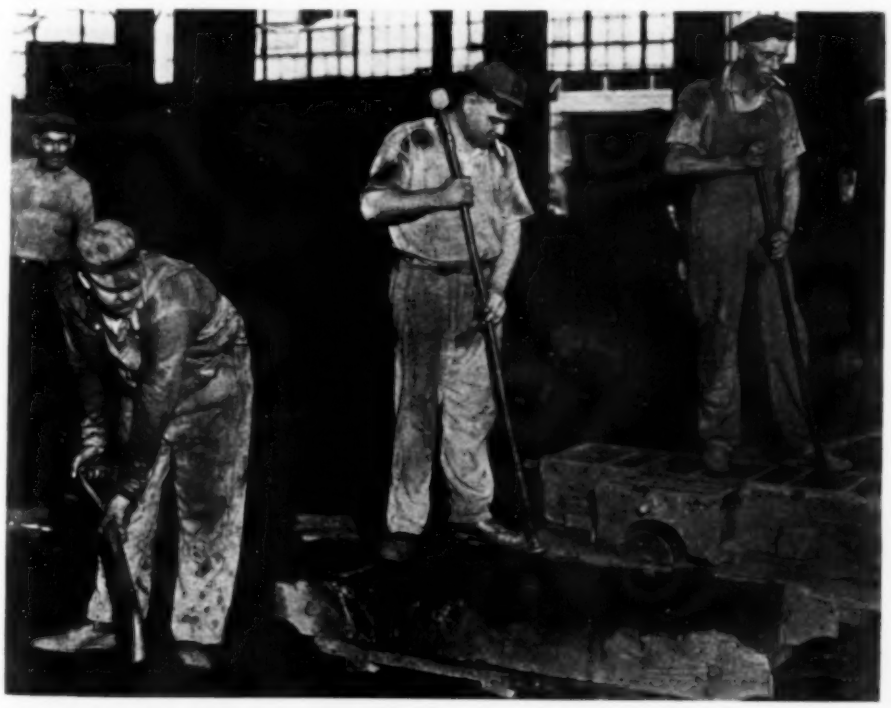


FIG. 9—A FEW GENERAL JOBBING FLOORS ARE MAINTAINED WHERE ODD PIECES ARE MADE IN THE OLD FASHIONED MANNER

Table V

Cast Iron Pipe Sales

	Water and Gas Pipe (Tons sold)	Soil Pipe (Tons sold)
1913	1,010,016	256,220
1914	938,297	222,483
1915	956,372	258,498
1916	934,262	279,707
1917	748,173	250,928
1918	508,300	111,373
1919	514,664	195,417
1920	636,862	249,653
1921	564,138	230,092
1922	926,577	356,872
1923	1,134,059	432,828
1924	1,365,272	476,078
1925	1,414,252	510,483

is less than 1 inch, the thickness of metal in the body of the pipe shall not be more than 0.08 of an inch less than the standard thickness. For pipes whose standard thickness is 1 inch or more, the variation shall not be more than 0.10 of an inch.

After the pipes are coated they are subjected to a hammer test while under hydrostatic pressure. Class *A*, *B*, *C* and *D* pipes, 20 inches in diameter and over are subjected to a pressure of 150, 200, 250 and 300 pounds per square inch respectively. Pipes of all four classes under 20 inches diameter are subjected to a test of 300 pounds per square inch.

Willing To Work

Breaking in colored help in the pipe shops probably has been the easiest of the many problems with which the organizers of these plants were confronted. No coercion was required to bring negroes from the cotton fields and the cane brakes to the bright lights and other real and imaginary delights and advantages of the cities. With comparatively few exceptions they are quick and adaptable, amenable to discipline and better adapted than white men to withstand high temperatures.

Tradition and custom still maintain a nice social distinction between the white and colored citizens of the South even though theoretically and technically they are all on an even footing. For example, white men and colored men work side by side under every conceivable industrial condition and in perfect harmony, but they will not sit side by side in trains or street cars.

The distinction is so well understood and observed that no colored man is given a position of authority in an industrial establishment. Reluctance of white men to work under a negro boss is conceivable, but the most peculiar feature of the situation is that colored men show the same attitude. They will accept orders only from a white boss. Also they are just as clever as any of their white confreres in spotting weak points in their bosses and governing themselves accordingly.

While it is true that transportation facilities in the South were limited when the pipe industry first was established, that condition no longer obtains. The familiar saying that trade follows the flag might be changed in this instance to read: Railroads follow the manufacturer. Birmingham now is served by nine main trunk lines and by a belt railroad that encircles the city.

A series of locks on the Warrior river facilitates transportation of incoming and outgoing freight through the port of Mobile where the United States government has constructed a system of docks equipped with the most modern loading and unloading equipment.

Wears Indefinitely

The pipe business is not so fortunate as the automobile and other industries whose prosperity is based on repeat orders for a product that wears out in a few years. Cast iron pipe lasts indefinitely. So well is this fact established that makers of soil pipe sell their product under an unconditional guarantee of 100 years service. Innumerable instances are on record of cast iron pipes that have been in constant service for over 100 years. Specimens are on exhibition in France, that were laid in the reign of Louis XIV to conduct water to the famous fountains of Versailles. Up to the present no other material has been found to compete successfully with cast iron in point of service over a long period of years.

Tuberculation, the name given to a growth on the inside of pipe and caused by certain waters, has been eliminated in recent years by a process of coating the inside of the pipes with cement or a bituminous preparation.

This is the second in a series of articles dealing with the cast iron pipe industry in the South. Succeeding articles will be presented in early issues of THE FOUNDRY.

The Editors.

Adds to Sales Force

Several changes have been announced in the personnel of the staff of Young Bros. Co., Detroit manufacturers of industrial ovens. D. E. Anderson, formerly a member of the staff of the Carrier Engineering Corp., Newark, N. J., will represent the Young company in the New England territory with headquarters at 10 High street, Boston. P. A. Meyer, formerly connected with the General Electric Co., Schenectady, N. Y. and for the past eight years associated with the Young Bros. Co., in the western New York territory, has been transferred to the main office in Detroit. G. C. Becher, formerly director of sales department, Ruud Mfg. Co., in the New York district, will take over the duties of Mr. Meyer in the western New York territory. His office will be 908 Ellicott square, Buffalo. J. J. Ferris, formerly associated with the Carrier Engineering Corp., Newark, N. J., has been assigned to the New York territory with offices at 30 Church street, New York, in charge of Mr. Thatcher.

FIG. 10—STANDARD FITTINGS OF VARIOUS SHAPES AND SIZES ARE MOLDED ON ROLLOVER JOLT MACHINES

Reduces Costs

By Controlling Oil Sand Mixtures

By Carl E. Schubert

FREQUENTLY foundrymen have a subconscious feeling that too much core oil is being used by the corerooms of their foundries in making dry sand cores. Apparently they are afraid to give orders to reduce this amount even though they are certain, at least partially, that a saving may be effected. The average foundryman is practical and reasons that it is better to have too much core oil in his sand mixtures than take any risk of his cores washing or breaking due to insufficient strength or dry bond.

To answer this kind of reasoning an effort was made to solve one phase of dry sand core making in a practical as well as in a laboratory way. The kind of dry sand cores referred to are those composed entirely of sharp silica sand and core oil. These cores are adaptable for coring such castings as cast iron manifolds, cylinder heads and the like.

Make Necessary Assumptions

To arrive at the solution of the problem certain assumptions have to be made before a correct conclusion may be supplied. Among the things which had to be assumed were the use of the best grades of core oil with a linseed oil base, correct baking temperatures for the cores, and the correct length of baking time. However, these were easy to assume, as every foundry which produces dry cores has solved these partially by experience and observation to suit their own needs.

In addition to the above assumptions a series of tests and test cores were prepared to have a basis to form conclusions. The test cores used throughout the tests were the standard 1-inch square and 14 inches long American Foundrymen's association's transverse test cores. These were used because it was believed that they would be representative of the average cross sectional area of small cores, and because a definite method of ramming cores could be followed. The method used was the standard method of the American Foundrymen's association.

To have a casting which these cores could "core out," a wooden pattern 10 inches long and 2 inches square with 2-inch core prints on each end was constructed. The pattern was split in the center and molded horizontally in the flask, half in the cope and half in the drag. A wooden set gate was provided exactly in the center of the drag portion of the pattern. The gate was ⅝-inches deep, 2½-inches long, and ¾-inch wide. This was done to have uniform conditions as much as possible. The casting was not gated directly on the top because it was thought that the average casting of that kind would not be gated in that way and that the force of metal dropping directly on the transverse cores would not represent a fair test. Photographs of the pattern, core box, hopper, ramming head and resultant core are shown in Fig. 1.

CARL E. SCHUBERT was graduated from the chemical engineering department, Notre Dame university, South Bend, Ind., in 1921. For five years he was associated with the Pullman Car & Mfg. Corp., as assistant chief chemist, and in 1926 became assistant superintendent of the foundry laboratory, University of Illinois, Urbana, Ill., which position he now holds. Mr. Schubert is coauthor of a manual on foundry practice entitled, "Foundry Practice for Engineering Students," and has made an intensive study of dry sand cores and core oils. This article is the second on the subject of dry sand cores by the author. The first appeared in the Sept. 1, 1929 issue of THE FOUNDRY.

Cores were made from the following sand mixtures and baked at a temperature of 450 to 475 degrees Fahr. for 45 minutes: 150, 125, 100, and 75 to 1 ratios of core sand to core oil. Sharp silica sand of approximately 70 mesh was used throughout the tests. In all cases 1 per cent by weight of water was added to the sand mixtures when mixing.

Rams Cores Carefully

Nine cores were rammed carefully from each core sand mixture and baked. Five of the cores from each sand mixture were tested for transverse strength upon cooling to room temperature. The results of these tests are shown in the accompanying table.

Eight molds were prepared in 12 x 16-inch pressed steel flasks, two castings being made in each mold. The moisture content of the molding sand was 7.5 per cent. Two cores from each sand mixture were set into four of the molds approximately 24 hours before pouring. This was done because it is known that the strength of dry sand cores is reduced approximately 50 per cent if placed in a damp atmosphere from 10 to 24 hours. No transverse tests are made on the cores that were allowed to remain in the molds for 24 hours before pouring because repeated tests have shown the truth of the statement.

The remaining eight cores, two from each sand mixture, were set just before pouring. At the time of pouring the temperature of the cast iron was taken with an optical pyrometer and found to be 2565 degrees

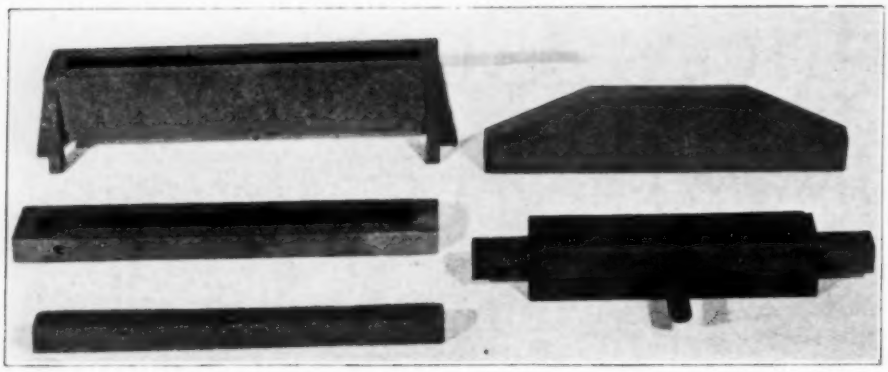


FIG. 1—TO THE LEFT READING DOWN ARE THE HOPPER, CORE BOX AND CORE. AT THE RIGHT THE RAMMER HEAD FOR THE HOPPER (ABOVE) AND THE PATTERN (BELOW) ARE SHOWN

Fahr. at the beginning of the pouring and 2465 degrees Fahr when finished or a loss of 100 degrees Fahr. during the pouring operation. It was found that four molds could be poured from one ladle of iron as the average weight of the casting, without gate or sprue, was nine pounds. The temperature of the iron was taken to assure average practical working conditions.

Determines Mixture

Castings taken from molds poured within 5 to 10 minutes after closing showed that cores made from a mixture of 100 parts of silica sand to 1 part of core oil by weight did not wash or break. The same results applied to cores made from 75 to 1 ratio of sand and oil. The remaining castings showed that cores made from ratios of 150 to 1 and 125 to 1 were too weak and either broke or washed. Photographs of some of the castings which have been sawed in two are shown in Fig. 2. A cross section of a normal hole produced by a sufficiently strong core is shown. A hole produced by a weak core also is shown. It will be noticed that due to the method of gating the weak core was bent upward by the force of iron to practically zero before breaking.

Castings taken from molds that were left standing with the cores set for 24 hours, showed all the cores broke but those made from 75 to 1 ratio of sand to oil. This superiority is indicated by the transverse strength tests as those cores having a 75 to 1 ratio of sand to oil averaged 16.55 pounds transverse strength when freshly baked and tested. Assuming that they lost 50 per cent of their strength while in the mold they should have had 8.28 pounds transverse strength. This would be enough strength to withstand the flow of iron and not break. This, of course, is confirmed by the actual results.

Gives Strength Value

Test No.	150 to 1 Ratio Transverse Strength in lbs.	125 to 1 Ratio Transverse Strength in lbs.	100 to 1 Ratio Transverse Strength in lbs.	75 to 1 Ratio Transverse Strength in lbs.
1	3.0	6.2	10.6	16.4
2	3.2	6.1	10.4	16.3
3	3.1	6.0	10.5	16.6
4	3.0	6.1	10.3	16.5
5	3.0	6.0	10.5	16.5
Avg.	3.06	6.08	10.56	16.55

The results of these tests show that if high grade core oils are used in the making of cores and ordinary diligence exercised in the care of baking and temperature of core ovens regulated that cores suitable for light casting purposes may be produced and successfully used from a ratio of 100 parts of core sand to 1 part of core oil. However, the cores must be set in molds just before closing and the molds poured quickly. If, however, it is necessary to wait for 2 or 3 hours for iron after setting cores and closing molds it is advisable to use a 75 to 1 ratio of core sand to oil.

Furthermore, the results obtained in these tests are backed up by actual experience and are only proofs of what already was known before the tests were performed. It was hoped that still smaller proportions of core oil could be utilized successfully such as 125 to 1 but this was found to be impossible with the present grades of quality core oils being produced.

Cores made using ratios of 100 to 1 will be easily removable from castings; that is, no chisels, hammers, air hammers, or core removing machines are necessary. When the casting is shaken from the mold it will be found that the core oil practically is all burned away thus allowing the core sand to be poured out of the casting.

Conditions Are Changed

Where green bond is necessary in small cores and is produced by the addition of cereal binders the results obtained do not hold good because more core oil is necessary. If the green bond is procured by the addition of molding sand more core oil is again necessary and no such ratios of 100 to 1 could be used. It is also reasonable to presume that if cores are made from 150-mesh silica sand, more core oil is needed than if one makes cores from a 70-mesh sand. There are more particles of sand in 100 pounds of 150-mesh core sand than there are in 100 pounds of 70-mesh sand. Consequently, the 150-mesh sand would require more core oil to attain the same strength as cores made from 70-mesh sand.

Foundrymen can effect a two-fold saving in the coreroom if they would investigate their own particular coreroom problems. The first saving would be in the quantity of core oil used and the second would be lower cleaning costs due to the cores being easy to remove from the castings.

Although no effort was made to investigate dry sand cores which require additions of green bond such as cereal binders, and molding sand, it is believed that savings could be effected by foundrymen if they would take the time and effort to experiment and test their cores both practically and in a laboratory way.

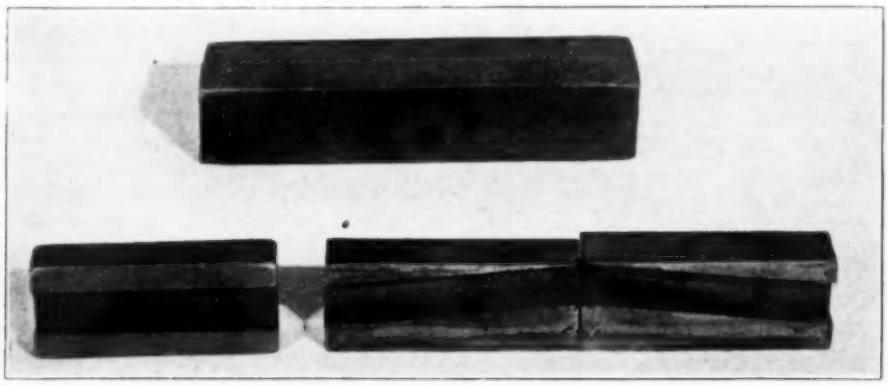


FIG. 2—(ABOVE)—AN UNSAWED CASTING. (BELOW)—VIEWS OF CASTING CUT IN HALF. THE CASTING AT THE LOWER RIGHT DEPICTS A TRUE HOLE, AND THOSE AT THE LEFT ARE WARPED

Questions & Answers on FOUNDRY PRACTICE

GENERAL

Core Resists Pressure

QUESTION

Can you give us a suitable core mixture for a core surrounded by a 1-inch thickness of iron or brass under a head of approximately 46 inches. The core is 1 x 8 inches in cross section.

ANSWER

Without a knowledge of the sands now employed it is rather difficult to suggest a definite sand mixture for the thin core to which you refer. We assume that you are getting satisfactory results from your regular core mixtures under ordinary conditions, therefore a slight adjustment is all that is required for this particular core which has to withstand severe pressure in addition to the usual heat encountered in pouring.

Any high grade refractory sand suitably bonded with either a liquid or a dry binder should clean out of the casting without any trouble. The ideal core for the purpose should be made from a clean silica sand bonded with oil, but many sands are available containing a small amount of natural bonding material and these may be used with discretion. The usual trouble with clay bonded core sands when subjected to intense heat and pressure is that the clay fuses between the grains and then vitrifies into a solid mass. If a sufficient number of vent passages are placed in the core this action is prevented partly or to a complete extent, depending on other factors and the core can be removed quite readily. In this particular instance we suggest you make a special core from clean, sharp sand bonded with oil in the proportion of about 1 to 40. Carry four ⅜-inch vent holes through the core so that the products of combustion may pass away readily.

Dry the core in the oven almost to the point of burning. Coat it fairly heavily with a good grade of blackwash and it will clean readily from the casting. Without a knowledge of the length, general contour, or the position the core assumes in the mold we cannot suggest any system for the wire reinforcements, but that feature probably has been worked out satisfactorily already. We only mention it because it may have to be modified to some extent on account of the large vent holes, which weaken the core to some extent, depending on the position it is to occupy in the mold.

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall—Cast Steel
H. A. Schwartz—Malleable Cast Iron
J. W. Bolton—Gray Cast Iron

All questions should be addressed to The Editor, The Foundry, Penton Building, Cleveland.

Q & A

Molds Not Poured Direct

QUESTION

We are thinking of converting a defunct blast furnace in this vicinity into a foundry where we can pour metal directly from the furnace into the molds. Can you give us any information regarding this new method of making castings?

ANSWER

Apparently you are under a misapprehension when you refer to making castings from blast furnace metal as something new. As a matter of fact all original iron castings were made from direct metal and continued to be made in that manner up to the close of the eighteenth century when the cupola was invented and placed in use. Gradually the cupola came into universal use until today nearly all the iron that is poured into castings is melted in this device. Practically the only exceptions are irons melted in air furnaces for special purposes and a bessemer iron, one low in sulphur and phosphorus, that is poured directly from the blast furnace into ingot molds and stools used in the open-hearth department of steel mills.

Many reasons led to the adoption of the cupola in preference to the blast furnace, but a proper presentation of the subject would occupy too much space at present. Probably the greatest single factor was the gradually increasing sizes of the blast furnaces and the comparatively small sizes of the first foundries devoted exclusively to the production of castings.

The adoption of iron and its conversion to the myriad uses of today was not accomplished in a day. The early founders had their own troubles in developing a market. Another reason was that customers early discovered that castings made from cupola melted metal presented physical characteristics superior to those poured from direct metal.

However, the reason that probably will appeal most strongly in your present case is that many attempts have been made in recent years to utilize direct metal in the casting field, but with the exception of the Ford plant in Detroit where a triplexing process is in use and the ingot mold instances already cited, none has proven successful. It is stated that one prominent pipe company in the South spent over $2,000,000 attempting to use direct metal and then gave up the experiment. Henry Ford melts part of his iron in the blast furnace, part in a cupola, mixes the two and superheats the mixture in an electric

furnace. A description of this process appeared in the Sept. 15, 1927 issue of THE FOUNDRY.

GRAY IRON

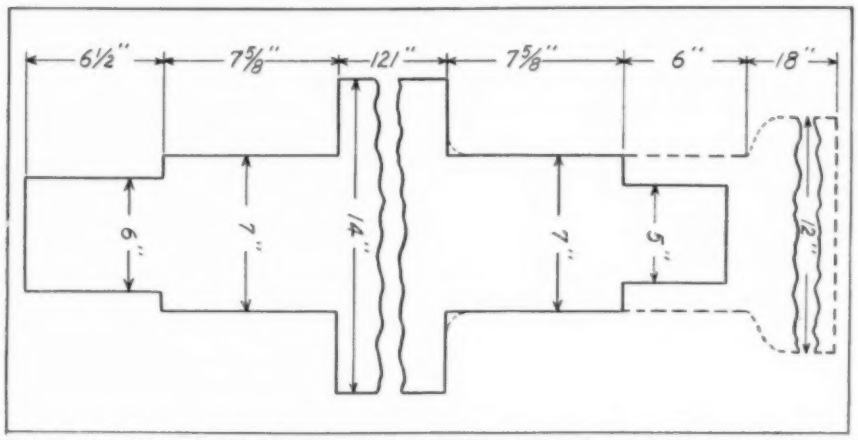
Iron Is Too Cold

QUESTION

We are forwarding to you a piece of a casting that we made recently. You will notice that it contains a number of blowholes and other imperfections. The casting was made from all heavy machinery scrap.

ANSWER

Examination of the piece of casting indicates that the holes in the casting result from two causes. One cause is that the iron is poured on the cold side, and the other is that the mold either is wet in spots or it is not vented properly. If the iron is poured hotter, some of the gases now carried in the metal will have a chance to get out before the metal is put in the mold. The other points of dampness and venting are molding troubles and the sand should be watched carefully. See that it is not too damp and is mixed thoroughly before using. If the sand is too dense, open it up with coarser sand, and vent both sides of the mold so that gases can escape freely.



THE 7-INCH NECK IS EXTENDED FOR 6 INCHES AND THEN FLARED TO 12 INCHES

Q & A

Feeding Head Needed

QUESTION

We have a solid cast iron roll to make which is approximately 12 feet in length, 14 inches diameter, provided with a neck 7 inches diameter at each end and a spindle 5 inches diameter at one end and 6 inches diameter at the opposite end. The casting is machined all over. We want to cut down the amount of machine work as much as possible and will appreciate your advice on whether it is safe to pour this casting without enlarging the neck or without providing a feeding head.

ANSWER

We suggest that you carry the 7-inch neck up about 2 inches higher than the spindle and then flare the mold out to 12 inches diameter for an additional 18 inches, as shown by the dotted line in the accompanying illustration. After the mold is poured, cover the iron in the riser with a shovelful of blacking and it will require no further attention. This represents standard practice in roll foundries and has been developed over a long period of years. The mold is poured through a whirl gate attached to the bottom neck. The iron is poured quite hot and is poured rapidly to insure a whirling motion while the mold is filling. The object of the whirling motion is to prevent any foreign material in the iron from adhering to the sides of the mold. After the casting has been cleaned, the sink head is cut off and the extra inch of metal on the neck is removed to form the spindle.

Q & A

Cast Rolls in a Chill

QUESTION

I have an order for some chilled rolls, weighing about 400 pounds each for a brick and tile manufacturing company. These rolls are employed in rolling the clay to take out the stones. I shall appreciate greatly your advice on the best mixture for these castings.

ANSWER

From your description we cannot decide whether the casting you refer to is a roller mounted vertically on an axle and designed to pulverize material in the bottom of a pan, revolving or stationary; or, a cylindrical roll mounted horizontally in pairs in fixed journals, driven from one end. Assuming that the casting is a roller traveling like a wheel in a pan, you do not state whether it is a complete casting, or a tire mounted on a permanent center so that it may be renewed when worn. The reason we raise these points is because the depth of chill and other physical characteristics depend on the thickness of the metal section and not on the total weight of the casting. A mixture that would give a chill 1-inch deep in a plate 1-inch thick only would show traces of a chill in a solid block 2 feet in diameter. Speaking off hand and assuming that the casting is a band or tire approximately 2 inches thick a suitable analysis would be: Silicon 0.80 per cent, sulphur 0.14 per cent, phosphorus 0.20 per cent and manganese 0.60 per cent. You can approximate this analysis by the use of equal parts No. 2 foundry pig iron, malleable or white iron scrap and steel scrap. If you have back numbers of THE FOUNDRY you will find articles of interest in the Oct. 15, Aug. 1 and Aug. 15, 1921 issues. The first deals with methods and mixtures employed in a prominent firm of clay machinery manufacturers and the others, the making of rolls for rolling mills.

Q & A

Shrinks Cause Trouble

QUESTION

In production of gray iron castings which involves light and medium weight work, we are troubled sometimes by shrinkage especially when light and heavy sections are joined. We have been using a certain brand of iron in our mixture and when we came to use part of a recent car of the same iron, trouble seemed more pronounced and feeding had no effect. After a call from the furnace representative, he advised that our trouble was caused by high phosphorus. It is peculiar that when this car was left out of the mixture, our difficulty ceased. We usually melt 50 per cent pig iron and 50 per cent scrap. The iron giving us trouble contains 2.62 per cent silicon and 0.86 per cent phosphorus, and the iron we are mixing with it contains 2.24 per cent silicon and 0.43 per cent phosphorus.

ANSWER

While phosphorus does have the tendency to cause shrinkage trouble due to the lower melting point of the phosphorus eutectic, we believe that your difficulty is due to other factors than that. While you do not state the analysis obtained in your castings, our calculations show that the silicon content is around 2 per cent, and your phosphorus around 0.60 to 0.70 per cent. You probably will get better results by increasing the silicon to around 2.25 per cent. You also may be able to eliminate some of the shrinkage by reducing the phosphorus. Moreover, by reducing the phosphorus, you will obtain a better iron that will withstand impact shocks that your present iron will not. We suggest that you lower your phosphorus to about 0.35 per cent.

It may be that your shrinkage

trouble is due to poor methods of gating. The thin sections freeze first and will pull away from the still pasty or even molten heavier sections of the casting.

Consequently, if your gate is at the thin section, insufficient metal will reach the place it is desired; that is in the heavier sections. Put the gate at the heavy section or use good sized risers at such points. Another point to be considered is the method of joining the thick and thin sections. If the change is abrupt, you will have shrinkage trouble more or less all the time. The only way to overcome it is to change the patterns so that the change from heavy to light section is gradual. This may be done by decreasing steps, or by a uniform decrease in section from heavy to light. A third method which is quite effective is to change the pattern design altogether so that the section is uniform or nearly so. Such a change of course, will have to be worked out by the engineer and the foundry.

A third possibility that may account for your trouble is an *off* iron. Chemical analysis of the iron will not show anything wrong, but it will ruin many castings when melted in the cupola. One feature of such an iron is the probability of finding little slag-like inclusions on the cope side of the casting. It also may show peculiar rough spots on the surface which have a grainy or kishy appearance.

Another characteristic of this iron is the appearance and action when molten. When it comes down the spout, it appears extremely hot, but is partly covered with a film which actively forms, breaks up and reforms. However, this apparently hot iron cools rapidly and sometimes if carried for some distance from the cupola, it becomes too cold to pour thin castings.

Q & A

Use Steel in Stoveplate

QUESTION

We operate a sheet metal department in our stove plant and produce quite a quantity of sheet steel scrap in gages ranging from 16 to 28. We want to run this scrap through our cupola in preference to selling it and will appreciate your opinion on the best method of getting it into shape for this purpose.

ANSWER

Thin sheet steel scrap made on the premises is used as part of the cupola charge in stove foundries in amounts ranging from 5 to 10 per cent. No special preparation is required. It is forked or shoveled into the cupola with the remainder of the charge. In a general way it may be stated that the practice is pursued more for the purpose of disposing of the accumulated scrap, than for any economies derived from the amount of cast iron scrap displaced. The melting loss is heavy on this class of steel scrap and due allowance must be made for this factor in making up the charges. You cannot depend on getting more than 50 pounds of molten metal from 100 pounds of scrap. In calculating the analysis of the iron entering the castings, provision also must be made for the change in silicon content caused by the addition of steel scrap which contains practically none of this element. To maintain your present standards of softness and machinability, you will find it necessary to use a slightly larger proportion of high silicon iron in your mixture.

MALLEABLE

Packing Material Data

QUESTION

What is considered the most satisfactory and most widely used packing material in which to anneal hard iron for malleable practice? Do you recommend the use of a sandblast sand about the size of large peas? If not, why not? What action takes place during annealing (if any) that causes the excessive reduction of the carbon content in the castings? These castings show no signs of having been burnt, no scale. The temperature of the oven was 1700 to 1750 degrees. The graphitic carbon content of the metal was 0.63 per cent and the combined carbon, 0.06 per cent. Should all top pots be sealed with an iron cover or will it suffice if the packing sand is heaped up 4 or 5 inches above the top of the pot, and the castings are 5 inches from the top edge of the pot; thereby having approximately 9 inches of packing sand for protection? Have you any other information on this subject that will help me?

ANSWER

Air furnace slag is an entirely useful and cheap packing material that is employed satisfactorily in the annealing of malleable iron castings. Any other reasonably fine, inert, refractory material is equally good. Such material includes crushed brick, quartz pebbles, sand of various kinds, etc. To prevent decarburization a reasonably fine material is important to diminish gas circulation. Possibly your material is too coarse. It certainly will require more of a seal at the top than a mere pile of sand. Air will of course, penetrate materials more easily than water, and certainly a layer of pea-size pebbles will be far from water proof. If the castings are quite thin, the decarburization down to a total carbon of 0.63 plus 0.06 = 0.69 per cent would not be abnormally low. However, if the castings are ½-inch thick, the results quoted are at least surprising.

It is quite possible to decarburize iron without any exterior scale. During annealing the reactions may be taken to be

$$\underset{\text{from castings}}{C} + \underset{\text{from air}}{O} = CO$$

$$\text{or } C + 2O = CO_2$$

Both reactions go on together and for a given temperature (say 1700 degrees Fahr.) and pressure (say 760 millimeters) the ratio of CO to CO_2 formed is fixed.

The reactions between iron and CO and CO_2 may be written

$$\underset{\text{iron}}{Fe} + CO_2 = \underset{\text{scale}}{FeO} + CO$$

$$\underset{\text{scale}}{FeO} + CO = \underset{\text{iron}}{Fe} + CO_2$$

The reactions do not represent all the facts accurately but indicate that CO_2 forms scale from iron and that CO forms iron from scale. For a given temperature and pressure there is a particular ratio of CO + CO_2 which is neutral to both iron and scale. The gases formed from burning carbon are richer in CO than this ratio and hence will not oxidize iron although carbon is removed, perhaps rapidly.

Since the amount of carbon removed depends upon the rate at which oxygen (air) circulates, the prevention of access of fresh air to the utmost degree is advantageous.

STEEL

Life of Steel Bottoms

QUESTION

What is the average life of cast steel annealing bottoms 66 x 156 inches? Steel sheets are stacked on these bases and then covered with a steel hood before they are placed in the annealing furnaces.

ANSWER

As in the case of nearly all castings subjected to hard steel mill service, the life of cast steel annealing box bottoms varies to a considerable extent depending on many factors, including method of handling and firing.

In a recent discussion on the methods of gating iron and steel castings, this point came up and one speaker declared that the average life of annealing bottoms is only 150 heats. You may compare this with the statement made on another occasion by the sales manager for a steel foundry that the life of these castings varies between 200 and 500 heats and that a fair average is 300. Naturally he takes an optimistic view. Contrast this with the statement of a sheet mill superintendent that the average life of a bottom 66 x 156 inches in his mill is 200 turns.

Problems in Nonferrous Founding

By Charles Vickers

Suggests Acid Dip

We are making a bronze that while satisfactory in other respects lacks the color the trade desires. We sandblast the castings but they are wanted in a light golden color on the outer surfaces that come in contact with the molding sand. Other brass foundries seem to surpass us in this respect. The castings are small and we were advised to use 88-10-2 *alloy but this failed to give the color desired. The mixture is not important, the color of the outside of the castings as they come from the sand is all-important and we are unable to obtain this effect. We do not use an acid dip.*

The most satisfactory way in which to get the color desired is by acid dipping the castings. The alloy to use consists of 79 per cent copper; 12 per cent zinc; 7 per cent lead and 2 per cent tin. Clean the castings by sandblast and then dip them in a bright dip consisting of 2 parts or gallons of sulphuric acid to one of nitric acid, and be careful not to inhale the fumes. After dipping the castings, wash thoroughly in running cold water, and then heat the castings by washing in hot water. However, if not accustomed to handling such acids, it would be advisable to make a contract with a plating works in your vicinity to do the dipping work. A red brass that will come out of the sand with a fine color can be made as follows: 85 per cent copper, 4 per cent tin; 5 per cent zinc and 6 per cent lead.

Q & A

Molds Bronze Liners

We contemplate the casting of bronze tail shaft liners for ships. The alloy will consist of 88-10-2 *copper-tin-zinc, known as composition G. The castings will range from six to eight inches and larger diameter, with wall thickness of from one to two inches, the length being from two to four feet. What do you recommend as the best method of molding—casting on end, or horizontally? Any information you can give us regarding the preparation of the molds, the method of gating, and the application of risers will be appreciated.*

It is a matter of opinion whether the best way of molding bushings is to make them horizontally or vertically. Some molders may have become accustomed to molding such castings vertically, and as they get good results, that is the best way for them. The writer personally prefers the horizontal method for bushings of small diameter, whether long or short, and pours them on the incline. Heavy bushings, such as used by rolling mills which may scale over 3000 pounds, are best made vertically and gated from the bottom and at several other places on different levels.

Small bushings, such as the shaft liners can be made nicely when rammed for horizontal pouring using a split pattern and a two-part flask. The latter should be long enough to leave at least 2 inches of sand between the ends of core prints and the ends of the flask. The core prints should be considerably longer than for upright molding, and six inches will not be any too long. If the core can be swept up on a stout, perforated iron barrel so much the better. The ends of the flask can be cut out to allow the barrel to protrude, and if the barrel is a stiff one, anchors in the cope can be dispensed with. With a core made in two halves then pasted together, on a 4-foot length, one or more anchors will have to be used in the cope, otherwise the hole will be out of true, as the core will spring. It is because of this springing of the core that some molders prefer to ram up such bushings vertically. The gate on the horizontal method of molding can be located on one end of the bushing. There also are a half dozen other places where it can be put. The mold can be inclined a little from the horizontal for pouring, and the gate can be put on the highest end, or on the lowest end and the metal forced up-hill.

There are two ways of making vertical molds. One is to ram the pattern up while standing on end, and for a 4-foot casting it is helpful to mold it in a pit, as it can be poured better. The molding sand should be drier than for the other way of molding, and in ramming, one thing is strictly taboo, and that is hitting the sides of the pattern with the rammer; keep away two inches. The second way of vertical molding is to mold in a two-part flask as for the horizontal method, then after the mold is completed, up-end it and pour through the end of the flask.

Q & A

Gives Brass Sand Data

We would like advice regarding the grade of molding sand suitable for the general run of light to heavy brass and bronze castings, in a production shop. Also, what grade is best for heavy castings of the same metal, particularly large bars of bushing stock, both cored and solid, and what grade of sand is best adapted for aluminum match plates, where sections are heavy and a smooth finish is essential?

For the general run of brass and bronze castings a grade of sand corresponding to a No. 1, Albany is most suitable, as a wide weight variety of castings can be handled in this sand. There should be no trouble making bars and bushings up to one hundred pounds weight each in this grade of sand, and some people use it for much heavier work. However, for making solid stock bars 6 inches and upwards in diameter, we advocate a more open sand than No. 1, thus a No. 2½, which is a 50-50 admixture of Nos. 2 and 3 makes a good, permeable mold. What is wanted in this latter case is a strong and refractory sand, so permeable that the bronze will lie in contact with the mold without simmering or other agitation, and this cannot be obtained with a fine sand.

For smooth surfaces on aluminum, it is necessary to use a fine grade of molding sand, and the ramming of such sand is highly important, for if the mold is packed hard, the molten aluminum will simmer, instead of laying quietly. The heavy sections must be fed, or be chilled to offset shrinkage.

Fundamentals of
FOUNDRY PRACTICE

Hard Ramming Usually Is the Cause of Scabs on Green Sand Molds While Scabs on Dry Sand Molds Usually Can Be Traced to Insufficient Drying

By Ivan Lamoureux

Interpreted in the Light of American Practice by Pat Dwyer

Part VII

GENERALLY the molder nails the face of the mold to render it more resistant and to prevent so far as possible, the formation of scabs.

In green sand molds, the scabs result from hard ramming, from defective venting, from excessive slicking with special tools, or from a poor location of the runner.

In dry sand molding, another cause may be added. The molds are not dried sufficiently. Causes producing the various reactions in the mold are so powerful, that the pins themselves cannot prevent them. Parts of the molds crush, other parts rise and nails will not prevent the iron from penetrating and filling the voids where the sand has disappeared. In such a case, pins and nails are useless. Their heads are found imbedded in the metal.

Defective Methods

Some molders nail their molds after drawing the pattern. However, this method may have serious consequences and is not recommended. Where the nails meet an obstruction, they bend and tear or break the mold. These breaks are serious if they occur near the edges where they cause sand to fall into the bottom of the mold. Placing nails after withdrawing the pattern requires slicking up with special tools. Slicking makes the mold impervious to the gases, and may cause scabs instead of preventing them.

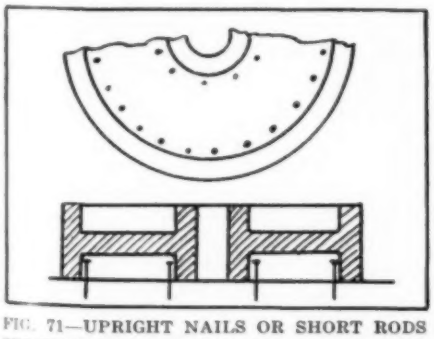


FIG. 71—UPRIGHT NAILS OR SHORT RODS STRENGTHEN THE SAND CLOSE TO THE HUB AND RIM

Use of Nails

RODS and nails are employed to reinforce the sand, particularly at points close to or actually on the face of the mold. Usually large rods and nails are placed in the sand during the ramming process while the smaller sizes of nails are forced into the sand from the face side after the pattern has been removed. Widely divergent opinions are held by molders on the efficacy or necessity of nailing certain areas of any given mold. In many instances nails are not regarded as actual necessities, but are inserted in the face of the mold as an insurance feature. Also variation in the character of the sand will be reflected in the practice observed in any given district. Repairing the mold involves care and skill on the part of the molder to insure a perfect match along the joint line between the cope and the drag.

The use of thin nails should be prohibited in foundries, because they lack stiffness. They cannot be used a second time. They pass easily through the meshes of the screen. It is impossible to recover them, and they remain in the sand where they may cause serious injury to the workers. They work under the sweep in sweep molding where they spoil the shape of the mold. They leave small black spots on the castings which spoil their appearance.

Small rods and nails used in preference to the thin black pins are nothing else than: Cast iron pins, made by a pointed vent wire; carpenter wire nails, and cut nails, Fig. 73. These nails are stiff and strong, and can be used many times. After each heat the refuse is screened and they are recovered.

Where drawing the pattern breaks off part of the mold the sand can be attached by nails and slicked. That is done often where the pattern is hard to pull out, either on account of high sides or because it has little draft.

Time to Nail

In nailing the face of a mold the nails should be pressed into place first. Then the sand is pressed with the tips of the fingers. The trowel is used to smooth the surface. If the nails are not placed until after the sand has been slicked, it will be necessary to go over the face a second time. Extra slicking with the tools usually reduces the porosity of the mold. If the nail meets a crossbar in the cope, a gagger or any other solid body, it will cause another rupture.

A large surface in the bottom of a dry sand mold should be formed with sand strengthened and well-mixed. If the facing sand layer is thin it is advisable to nail the mold, to unite the two layers of sand and prevent them from separating from each other during the drying out of the mold.

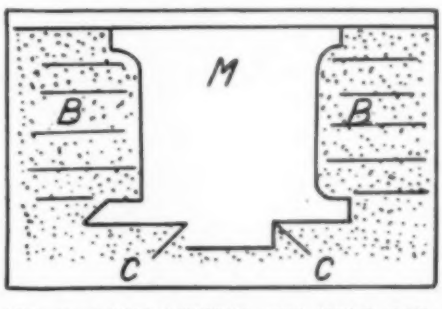


FIG. 72—SAND AROUND THE MOLD CAVITY *M* IS REINFORCED BY THE NAILS AT *CC* AND THE RODS AT *BB*

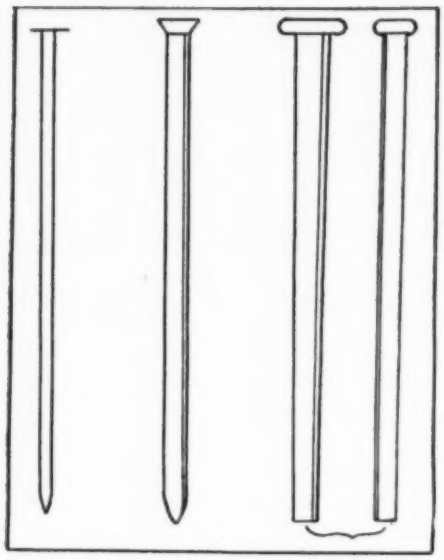


FIG. 73—(LEFT)—SLIM PIN; (CENTER)—WIRE NAIL; (RIGHT)—CUT NAIL

When molding a wheel from a pattern, as shown in Fig. 71, cracks may appear in the sand of the cope and cause sand to break off at the moment of pouring. The molder should reinforce the sand with nails before the sand is rammed, rather than wait until the pattern has been removed.

In flask molding after the pattern is placed on the pattern board, the hollow in the pattern is filled with sand. Then the nails are pushed in as shown in Fig. 71 about 1¼ inches from the edge and about 1½ to 2½ inches apart. The sand around the hub is reinforced in the same manner. The sand is pressed down strongly with the fingers. In filling the flask with sand for the first ramming the rim and the hub are bared to prevent touching them with the rammer. The remainder of the flask is filled and rammed in the usual manner. After the drag is rammed it is rolled over and bedded on the floor and the parting sand is sprinkled over the joint in preparation for the cope.

Without a Pattern

If the molding is done in the floor the pattern is tried two or three times on its bed. Then the face is nailed and vented and the pattern is returned permanently. The two foregoing methods apply to the majority of cases that occur in a foundry.

Cast iron, wrought iron or steel rods or wires may be used instead of nails.

In molding the wheel shown in Fig. 71, it is not at all necessary to use nails or rods.

In a mold with high vertical walls, and with a flange at the bottom, Fig. 72, cast iron, wrought iron, or steel rods are placed at each tamping at intervals of 2¾ to 3⅛ inches thickness to strengthen the walls. In this instance no nails are needed after withdrawal of the pattern.

If the mold is made in a flask, a row of nails is placed around the core print, to prevent it from breaking away, at the time of trying the cores.

Many molders nail a mold similar to that of the plate shown in Fig. 63, whereas they will not nail it if they mold the plate as shown in Fig. 64. In the second position, nailing is impossible. The molder has no access between the two walls. The same rule applies to the rims of pulleys, the spokes or any other inaccessible edges. In these various molds the molders do not nail and the castings do not look any different from those made in nailed molds.

Apparently, nailing is dictated more by custom and habit than by any well-defined rules. The experienced molder should be able to determine in advance whether nails should or should not be used.

In flask molding, gaggers are used to hold masses of sand in the cope, particularly bodies of sand which hang lower than the joint, or which are isolated to the point of losing all cohesion.

The molder uses gaggers of various types: Wrought iron or steel gaggers, cast iron gaggers, wooden gaggers, usually known as soldiers.

Location of Gaggers

The ordinary gagger, round or square in cross section measures ½ inch and ranges in length from 4 inches to 12 inches. Special gaggers for various purposes may vary widely from these dimensions. Although the single gaggers, Fig. 74, are in most common use, the double gaggers, Fig. 74, are preferable. The load of sand hanging to the cope is balanced by the two equal tips *a* and *b*. The load of sand on a single tip tends to deflect the gagger from the vertical. If the gagger extends considerably above the top of the cross-bar, dangerous bending may result. A double gagger will support almost as much sand as two single gaggers. This is a desirable feature. It reduces the weight of the mold, the number of gaggers required and leaves more space clear for the rammer. The double gaggers permit the molder to ram sand under the cross-bars. Their only disadvantage is that they are rather expensive. Each one is welded at the center of the foot.

In locating the gaggers, care should be taken to place a sufficient number of gaggers to carry the mass of sand. A square section gagger with a 4-inch toe, can support a column of sand 4 inches square. However, too many gaggers increases the weight of the cope and restricts the escape of the gases. The gaggers are placed quite plumb against the cross-bars of the flask. This arrangement facilitates tamping the sand and ramming the gaggers up against the bars. Heads of the gaggers are hooked over the bars. Where the length of the gaggers is less than ⅝ of the height of the cross-bars, headless gaggers are used. The tamping of the sand itself holds these gaggers in place.

Gaggers at Angle

Sometimes through force of circumstances the molder has to use gaggers that are too long or too short. In placing gaggers that are too long, Fig. 75, the molder should dispose them in a manner to prevent them from projecting above the flask. Projecting gaggers really cause various inconveniences. During the process of turning over the flask, the projecting ends of the gaggers may be struck and in that way cause sand to drop off on the inside of the mold. The projecting ends of the gaggers make it difficult to weight the mold down for pouring. Finally should the shrink-head run over or should metal from any cause flow over the top of the cope, the heads of the gaggers would become imbedded in the iron, to form a mass almost impossible to separate.

Consequently, when the gaggers are too long, they should be placed at an angle, so that their heads rest against the cross-bars of the flask. Then they appear criss-crossed, as in Fig. 75, to equalize the strain.

If too many gaggers are inclined in the same direction, the pressure exerted by the mass of sand under them will cause the gaggers to pull away and cause the cope to sag. The weight of a gagger is 4½ times that of a like volume of sand. The weight alone of the gaggers will cause them to sag

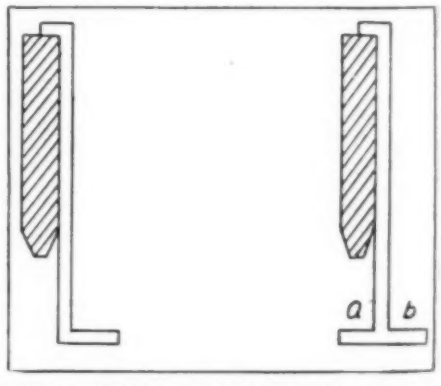


FIG. 74—SHOWING APPLICATION OF SINGLE TOE HOOKED GAGGER AT LEFT AND ONE WITH DOUBLE TOE AT RIGHT

and consequently cause the sand to fall with them.

Short gaggers can be used, gaggers that do not hook on to the cross-bars, if the part of the gagger pressed against the cross-bar, the shank, is one-third longer than the part which extends underneath and known as the toe. Hence, if the part of the gagger pressed against the cross-bar measures 6 inches the part which rests on the pattern or joint should not exceed 4 inches.

To reach hollows in the cope which are hard to get at, the gaggers should be placed obliquely by simply hooking them on the crossbars. Care should be taken to cross the gaggers to balance the strains developed. When the gaggers are placed obliquely instead of adhering closely to the crossbars of the cope, the tamping of the sand becomes difficult. At each blow of the rammer, the molder risks hitting the gaggers with the head of the rammer and thus produce hard spots where they rest on the pattern which would cause scabs on the resulting casting.

Dangers to Avoid

If the molder is using a sweep on a sand pattern, the gagger will penetrate into the pattern and will have to be either knocked back or pulled out. During the ramming process an oblique gagger will be forced into a position where the toe will rise while the heel will drop down as shown in Fig. 76.

Gaggers never should be hooked over the ends or sides of a flask. The heads constitute a risk at all times either when rolling over with the chains or beam and slings, or, when a workman passes close to the flask with a wheelbarrow or anything else.

Placing gaggers in that manner constitutes an inconvenience in setting the cope down after it has been lifted from the drag, also in placing the rails for the weights before pouring. However, an exception to this rule is a flask less than 16 inches along a side which does not carry inside bars.

Thin flat iron gaggers 1/3 to 1 inch or 2/5 to 4/5 inch have been receiving preference from some molders, because, at first glance their carrying surface appears to be considerable. However, they present serious disadvantages. Under certain conditions they may be tolerated for reinforcing parts of the mold that do not come in contact with the metal.

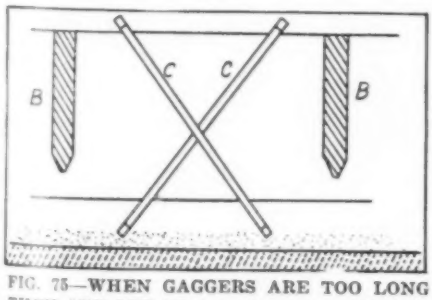


FIG. 75—WHEN GAGGERS ARE TOO LONG THEY ARE SET AT A SLANT TO PREVENT THEM FROM PROJECTING

Disadvantages of flat iron gaggers include the following: The shanks bend and give under the weight of the sand. They cover a comparatively large surface of the mold and the escape of the gases is impeded seriously. On account of the large surface of the gagger the adhering sand may drop off on pouring.

In the United States, gaggers of various sizes are made from twisted steel bar stock. These gaggers present a minimum of weight, a maximum of adherence and increase considerably the porosity of the mold.

Cast iron gaggers usually are molded from a plate or board to which

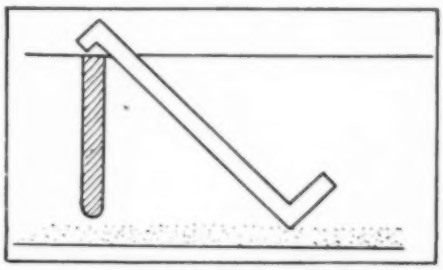


FIG. 76—A GAGGER SET AT THIS ANGLE IS OF NO PRACTICAL USE

the necessary patterns are attached. This plate is pressed on a level bed of soft sand and the resulting gagger impressions are filled with iron from a hand ladle. Cast iron gaggers are heavy and brittle. A large number are broken at the time of shaking out the molds. They are not recommended, and only should be tolerated in exceptional cases; when no other type of gagger is available, or when no others are available of the required length. In many instances the molder may find it preferable to make and utilize an arbor, crab or frame to cover exactly the shape of the mold. Cast iron gaggers are used advantageously to reinforce the sand near the edge of the flask at the joint, but they are of a greatly reduced size and usually are cast in suitable chill molds.

In the United States, metal molds similar to that shown in Fig. 77 are used for making gaggers. They are made up of a cast iron plate *A*. 3 1/5 inches thick, with molds for several gaggers, riser and pouring gates on each side, and of two bearing pedestals *BB* which permit presenting each face of the plate in turn for casting.

The axis of the bearing pedestals is eccentric with respect to the axis

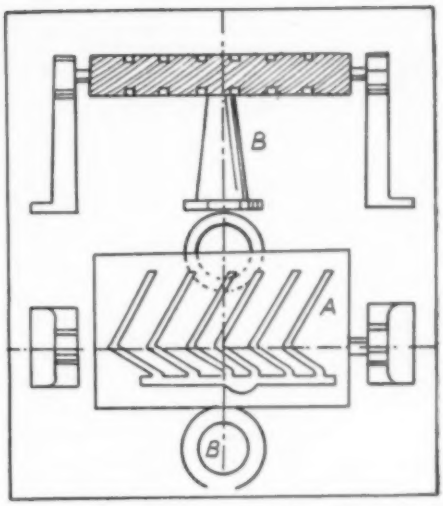


FIG. 77—PLAN AND ELEVATION OF AN IRON MOLD FOR MAKING GAGGERS

of the plate. The plate in turning strikes alternately against the posts *B* and *B* placed on each side, and on a level with the plate.

When the metal gaggers in the mold have cooled sufficiently, the plate is turned over. The edge strikes against either post *B* or *B* and the gaggers are jarred out.

Metal then is poured in the molds in the other side of the plate. The pouring is continued alternately from one side of the plate to the other until the required amount of gaggers is obtained. Gaggers thus made up are uniform in size and their cost is not excessive.

In the United States foundrymen use wood flasks extensively. Also, instead of wrought iron, steel, or cast iron gaggers, at times they use pieces of wood called *soldiers* in which the cross section varies with the length.

Boards 1 inch thick are sawed to the desired length and then either sawed into strips lengthwise or split with a hatchet. The soldiers most frequently used vary in length between 4 and 12 inches and in cross section between ½ x 1 and 1 x 1 inch. Special lengths readily are made for special occasions.

Foremen's Club To Meet

The convention of the National Association of Foremen will be held in Toledo, O., June 6 and 7. Meetings will be held in the Civic auditorium and the Chamber of Commerce. Harry J. Baumaker, 316 Tenth street, Toledo, O., has been appointed convention secretary.

George A. Miller, formerly connected with the Dodge Mfg. Co., Mishawaka, Ind., now is associated with the Austin Co., Cleveland.

Committee Activities

Hold Interest at Detroit Meeting

American Society for Testing Materials Combines Technical Sessions with Spring Committee Conferences

INTEREST in testing methods and the painstaking work involved in setting up specifications and testing practice attracted more than 500 registrants to the spring meeting of the American Society for Testing Materials held in Detroit during the week of March 17. During the period from Monday until Friday, 119 different committee meetings were held and in addition two technical sessions, Tuesday attracted an attendance at both morning and afternoon sessions of more than 200.

Many important developments affecting the foundry industry are reflected in the committee activities, and information relating to the industry was presented at the technical sessions. Proposed revisions in testing methods, the adoption of a classification of gray iron in accordance with physical properties and uses were considered in the sessions of committee A-3 on cast iron and its various subcommittees.

Gives Personnel

Committee A-3 is headed by Hyman Bornstein, Deere & Co., Moline, Ill. Other gray iron subcommittees which met were those on high test cast iron of which J. W. Bolton, Lunkenheimer Co., Cincinnati, is chairman, the subcommittee on impact testing, J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, chairman, and the committee on correlation of test bar and casting headed by R. S. MacPherran, Allis-Chalmers Co., Milwaukee.

A tendency toward higher standards in malleable castings was indicated in the deliberations of committee A-7, headed by W. P. Putnam, Detroit Testing Laboratory, Detroit.

The Wednesday morning technical session was called to order by Pres. T. D. Lynch, Westinghouse Electric & Mfg. Co., East Pittsburgh, who introduced F. O. Clements, technical director, research laboratories. General Motors Corp., Detroit, vice president of the American Society for Testing Materials. A paper by A. L. Boegehold, metallurgist, General Motors Corp., sketched the relationship between accurate foundry technical control and effective production of automotive cast iron. He outlined points in sand testing, the relation of burning rates of coke to efficient melting, the application of special types of cupolas, methods of control of mixtures and the properties of various automobile cast irons. In the discussion R. H. Watson, Semet-Solvay Co., Detroit, noted that the rate of combustion of coke is not a factor of porosity, but is dependent upon the kinds of coal from which the coke is produced. He stated that dry blast pig iron is hard to break but easy to drill and that the moisture content in the air of a blast furnace affects the temperature of the metal in a direct manner, with the assumption that a similar condition may follow in the cupola. He remarked that the tendency is toward definite standards for both pig iron and coke which will remove some of the variable factors encountered in foundry operation.

Local Hospitality

COMPLETE arrangements for the joint committee meetings and sessions were handled by Detroit members of the A.S.T.M. Inspection trips were made to various manufacturing plants. The local committee included F. O. Clements, chairman; P. J. Baker, T. A. Boyd, J. B. Dailey, W. C. DuComb, C. L. Foreman, W. H. Graves, C. G. Heilman, E. J. Hergenroether, N. P. Jarrait, E. J. Lowry, J. L. McCloud, H. W. McQuaid, H. C. Mougey, W. G. Nelson, W. M. Phillips, W. P. Putnam, R. H. Watson, and A. E. White.

Charles Pack, consulting engineer, New York, spoke on advances made in die cast metals for automotive use which he divided into tin base, lead base, zinc base, aluminum base, magnesium base or copper base alloys. Tin and lead base alloys find service mainly in bearings. More than 70 per cent of the die castings used in automotive construction are produced from zinc base alloys and practice has demonstrated that of these practically all castings can be produced from an alloy containing over 90 per cent zinc with the remainder aluminum and copper.

Magnesium alloys are favored abroad by reason of the low cost of magnesium. If the cost of the metal were lowered, it is the author's opinion that a demand would be created which readily could be met by American die casting manufacturers.

Aluminum bronze is the largest classification of copper base alloys for die casting. In general this material readily may be superheated and poured into gravity type permanent molds. Heat treatment of aluminum die casting alloys is said to be impractical due to blow holes encountered.

Reviews Developments

New developments in light metals for automotive use were reviewed by Dr. Zay Jeffries, consulting metallurgist, Aluminum Company of America, Cleveland. Dr. Jeffries tabulated aluminum and magnesium alloys in his paper with their composition and properties. Practically all of the known alloys of these metals are used in the automotive industry. At present such alloys also are favored in aircraft construction where cost is not important as compared with saving in weight. Outboard motors, diesel engines and motor parts for trucks and buses, all of which are heat treated types of castings, cover the remainder of the field.

In the early history of automobile construction more aluminum was used than is the case today. This was due to the ease of machining, the need for reducing weight in the slow speed motors and the high cost of dies and machinery for forming parts on a low production basis. Formerly, many chassis parts, the crank case, cylinder head, pans and gear cases were made of aluminum. In 1919 the Aluminum company constructed an automobile using aluminum in practically every part. This car with 133-inch wheel base weighed 1000 pounds less than a

(*Concluded on Page* 144)

The FOUNDRY Family Photograph Album

Upper Left

G. M. LESLIE

Bass Foundry & Machine Co., Fort Wayne, Ind.

Upper Right

G. E. BEAN

Malleable Iron Works, New Britain, Conn.

Lower Left

C. E. SCHLEY

Pennsylvania Bronze & Brass Co., Philadelphia

Lower Right

F. F. WARD

Meltrup Steel Products Co., Beaver Falls, Pa.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

HINTS FOR THE CORE ROOM

(*Continued from Data Sheet No.* 802)

Metal inserts and driers

To prevent metal inserts and chills from blowing the following coatings are recommended.

A solution of alcohol and rosin.

Shellac.

Dip in emulsion of water and red lead and dry thoroughly.

If inserts are heated until they are hot and the mold poured while they are still warm blowing seldom occurs.

CONVERSION TABLE FOR BOND RATIOS

Bond Ratio Bond to sand by Volume	Binder Gallons per ton sand	Gallons per cu. yd. sand
1 to 10	13.5	20.25
1 to 20	6.75	10.125
1 to 30	4.5	6.75
1 to 40	3.4	5.1
1 to 50	2.7	4.0
1 to 60	2.25	3.375
1 to 70	1.9	2.85
1 to 80	1.7	2.5
1 to 90	1.5	2.25
1 to 100	1.35	2.0
1 to 110	1.2	1.8
1 to 120	1.1	1.6
1 to 130	1.0	1.5
1 to 140	0.9	1.4

Approximate Sand Measures

1 cubic yard = 202 gallons = 3000 pounds = 27 cubic feet.
1 cubic foot = 7.5 gallons = 110 pounds.
1 ton sand = 135 gallons.
1 wheelbarrow = 14 to 18 shovels = 100 to 120 quarts = 25 to 30 gallons = 370 to 450 pounds.
1 shovel = 1½ to 2 gallons = 6 to 8 quarts.
1 gallon = 231 cubic inches = 14.5 pounds = 4 quarts = 8 pints = 32 gills.

Inserts also may be sandblasted to remove all rust, dirt, and foreign matter and then dipped in kerosene before setting in the mold.

To make inserts hold tight they should be roughened, nicked, or threaded to provide an anchorage for the new metal. Fusion or welding seldom will be complete unless the metal is extremely hot and allowed to flow over the insert surface for a short time.

Core driers made from close grained iron do not scale as readily as an open grained iron.

(*Continued on Data Sheet No.* 808)

HINTS FOR THE CORE ROOM

(*Continued from Data Sheet No.* 807)

A good way to remove scale from a core drier is to burn it off. The empty driers may be placed in a core oven for a few bakes.

The scale can also be sandblasted off.

Properties and Behavior of Binders

Migration of the binder to the surface of water soluble binders is retarded greatly by the addition of clay bond to the mix.

Frozen sand prevents the proper distribution of the bond and requires more bond than sand in the proper condition.

Hard and dense cores can be made from sand blast dust mixed with ordinary sand in any desired proportion. These cores are used to give a slightly chilled surface to such castings as sheaves, sprockets, etc.

To produce green bond in core sand, use wheat flour, corn flour, or clay bond.

Brittleness in oil sand cores may be produced by: An excessive amount of rosin in the core oil, or by baking too fast.

Cores sticking to driers may be caused by: Too much binder, dirty driers, rough surface on driers or by excessive moisture.

Use of hot sand in the mix reduces the effectiveness of the bond and causes a rapid drying out of the sand before it is used.

WEIGHT OF BINDER FOR DIFFERENT RATIOS

Bond ratio by volume	Binder Gal. per ton sand	Core Oil (7.5 lbs. per gal.) Lbs.	Wheat Flour (5.5 lbs. per gal.) Lbs.	Corn Flour (4 lbs. per gal.) Lbs.	Goulac (5 lbs. per gal.) Lbs.	Pitch (4 lbs. per gal.) Lbs.	Rosin (9 lbs. per gal.) Lbs.
1 to 10	13.5	102.5	74.25	54.0	67.5	54.0	121.5
1 to 20	6.75	50.60	37.1	27.0	33.75	27.0	60.75
1 to 30	4.5	33.8	24.75	18.0	22.5	18.0	40.5
1 to 40	3.4	25.5	18.9	13.6	17.0	13.6	30.6
1 to 50	2.7	20.25	14.9	10.8	13.5	10.8	24.3
1 to 60	2.25	16.9	12.4	9.0	11.25	9.0	20.25
1 to 70	1.9	14.25	10.5	7.6	9.5	7.6	17.1
1 to 80	1.7	12.75	9.4	6.8	8.5	6.8	15.3
1 to 90	1.5	11.25	8.25	6.0	7.5	6.0	13.5
1 to 100	1.35	10.25	7.4	5.4	6.75	5.4	12.0
1 to 110	1.2	9.00	6.6	4.8	6.0	4.8	10.8
1 to 120	1.1	8.25	6.1	4.4	5.5	4.4	9.9
1 to 130	1.0	7.5	5.5	4.0	5.0	4.0	9.0
1 to 140	0.9	6.75	5.0	3.6	4.5	3.6	8.1

This table includes the binders which are used alone as binders but of course the table can be used also to determine the weight of binder in sand mixes having several bonds.

To produce green bond in core sand, use wheat flour, corn flour, or clay bond.

Brittleness in oil sand cores may be produced by: An excessive amount of rosin in the core oil, or by baking too fast.

Cores sticking to driers may be caused by: Too much binder, dirty driers, rough surface on driers or by excessive moisture.

Use of hot sand in the mix reduces the effectiveness of the bond and causes a rapid drying out of the sand before it is used.

(*Continued on Data Sheet No.* 809)

What Is the *Undeveloped Wealth* of the STEEL FOUNDRY?

By George Batty

THE undeveloped wealth in the steel foundries of this and other countries consists largely in the potentialities of the men employed, particularly superintendents and foremen of various grades. There is not a sufficient appreciation in the minds of executives of the disabilities under which these men labor. They do not receive the whole of the credit to which they are due because of the limitations under which they are compelled to operate. The limitations are of two types. First there is an insistent urge that production be secured along well established lines of procedure such as are largely traditional in the industry. In the second place as a general rule, these men are so overburdened with the multitudinous cares of attention to detail that they have no opportunity to set the mind free to explore the avenues of potential variations from orthodox practice. It cannot be considered fair to expect a man to be regularly a competent executant and at the same time an inventor, or an innovator.

Cannot Translate Correctly

It is within my experience that a number of foundry foremen are keen observers, that they are able to notice small variations from the normal behavior of steel or from the normal behavior of castings as they cool down from solidification temperature. However, they have not had the peculiar training which fits them to translate correctly all their observations, nor do they have much opportunity to conduct such a series of experiments as would serve to identify an abnormality with a definite set of conditions. They are compelled day by day to work upon orthodox lines so that castings may be produced as an orthodox cash reflex of the estimate they have put in as the basis for the selling price of the casting. The greatest fear—it is almost an ever present fear—in the minds of foundry superintendents is that they may fail to produce castings at the price indicated in their cost estimate. The very exigencies of the situation compel them to be orthodox.

Progress is rendered possible as a result of sensible variations from the orthodox and it must be remembered that if a man is compelled to work along orthodox lines such a handicap is imposed on him that he is unable to progress. I do not mean that superintendents are forbidden to make experiments, but I much doubt whether many, particularly those operating relatively small foundries, ever undertake a real investigation where results are checked and rechecked to establish a new principle.

The steel foundry has a practice which is primarily the result of variations from the practice used in producing castings from metals more easily manipulated in sand than is steel. In steel foundry practice, it is possible to identify the origin of certain details of procedure with the procedure established in producing castings from other metals. Of course there has been some modification made by the practitioners in an attempt to meet the new conditions, but there remains in steel foundry practice a good many undesirable legacies from the older arts of casting other metals. It is even safe to say that certain details of practice which are almost traditional in dry sand molding have been carried forward and are used in green sand molding where such practices are definitely wasteful.

Much Remains To Be Done

Along mechanical lines a great deal has been done in the steel foundry in recent years to decrease production costs but comparatively little has been done to establish a regular technique to be applied in the production of steel castings. No matter what any one man may have done in the steel foundry business he remains humble because there is still so much remains to be done. For example few people in a steel foundry carry with them constantly a realization that the metal cools and solidifies almost entirely as a result of the absorption of the heat of the metal by the mold and that if

Interest Scattered

WHILE the author has discussed the undeveloped wealth of the steel foundry, the discussion may well be considered by managers of malleable, gray iron and nonferrous foundries. The information which is gained daily by the men in actual contact with the job offers great possibilities for dividends if steps are taken to correlate the observations. This article is abstracted from a paper presented at the Pittsburgh meeting of the Steel Founders Society of America, held Dec. 12, 1929. The author is technical director, Steel Castings Development bureau, Philadelphia.

there is differential absorption of heat at different parts of the mold, certain results are bound to ensue. Such a statement would lead to a definition, and then to the establishment of a principle which could be applied successfully by all concerned.

The scientific mind is being applied to steel foundry problems but in some instances within my own knowledge the individual with the scientific mind and with scientific training has failed to make any marked improvement when attacking a foundry problem because he has not attached due significance to the tremendous number of variables which enter into the production of steel castings. Not for an instant do I attempt to deprecate the efforts of science—we need more and more application of trained scientific minds to the steel foundry industry but I do affirm that some apostles of science have been unfortunate in their attempts to investigate some of the problems which they have been called upon to tackle in steel foundries.

Is Not Understandable

The practical man is suspicious of anything he does not understand and, in particular, he is suspicious of language which conveys nothing to him except his own inability to understand what is being talked about. In many instances this will promote the condition which has been classified as "inferiority complex" and the promotion of fear promotes failure. To develop the potential wealth of foundry operatives, it is necessary to have their confidence. Without their confidence, we can hardly hope for their co-operation. It would seem that there is a definite link needed between the scientist and the steel foundry practitioners, the practical men who, day by day, travel the seemingly dreary path of routine duties. This link is the technician the man who will translate into understandable language the definitions of the scientist and who will also correlate the experiences of a number of competent workmen with a view to establishing what are fundamentals and what are variants of good practice.

In 1920 I was called upon to make a survey of melting shop practice in the mills which supplied steel to a large manufacturer of automobiles. In these mills I saw all—or what I considered to be all—the details of good practice in furnace operation, pouring pit preparations, ingot mold design and treatment, and in pouring practice. But in no one plant were all the details of good procedure applied.

In a similar way I have observed procedure in steel foundries and it is safe to say that by selecting the best details of method from each plant we might arrive at something closely approximating perfect practice. However in every foundry there seems to be more or less adherence to traditional usage which is unworthy of perpetuation. There are redundancies and personal idiosyncrasies that should be eliminated to arrive at economical and sound practice.

There also are variables which tend to operate against uniformity of procedure. The variants arise largely through infortuitous modifications of what are considered desirable conditions and it is no simple matter to evolve formulas which predicate immunity from variability in the many operations and materials that go to the making of steel castings.

Foundry foreman and superintendent are, as a general rule, men who have reached their present position by way of the sand pile and, although we cannot expect them to be metallurgists or chemists, we often find that they have information that may lead us to important conclusions if this information is properly studied and correlated, particularly on distortion and differential contraction of castings. First we have to give them a medium of expression; then we have to find an adequate translation for their expression and, while I believe that the foundry superintendent of the future will be essentially a metallurgist, I still think that we need to take advantage of the hidden store of knowledge which is awaiting expression and exposition within the minds of the body of men we refer to as our superintendents and foreman.

Know One Procedure

In observing practice in quite a number of steel foundries I have found details of procedure, all designed toward one ultimate end, which can be correlated and produce a principle. You all know that in the making of steel castings a multitude of details must be observed. These details are relative to some principles which should be established and expressible as a precise definition or as a formula.

You cannot expect your foreman and superintendents to know anything other than their own particular procedure, largely a legacy from their tutors. I am quite prepared to agree with my scientist friend who says that the steel foundry is ample and lavish in opinions but shy on facts, but we have yet to have demonstrated the best method of determining what is worthy tradition and what is worthless, what is substantial opinion and what is erroneous, what is fact and what is assumption based on an insecure premise. My own opinion is that the best results are to be obtained by providing the missing link which will connect the scientist with the empiricist. This view is not novel, it was expressed years ago by Melmoth, and I have little doubt that a similar expression of opinion has been made by other men.

You will want to know how the technician can develop the potential wealth which lies in your foundries and I think I could best reply to such a question by saying that he must become a student as well as a teacher, must be able to translate the language of the scientist to the practical man, must be able to transform the careful observations of the empiricist into orderly principles, and must, if he is to be successful assure the practical men of his appreciation of their difficulties of expression and of his desire to transform into understandable order the apparently conflicting experiences which beset the average superintendent or foreman.

Governing Conditions

Regularity of product must depend upon regularity of all conditions governing the manufacture of that product and the technician must, therefore, evolve for the use of the workmen definite formulae and definite principles which, while correct, must also promote a feeling of confidence in the mind of the man who is to apply them, even though they appear contrary to the tradition in which he has been raised. This calls for intelligent handling of the practical men by the technician and the great fundamental of their relations must be a sympathetic understanding. The practical man continues to work along orthodox lines, along the lines indicated to him during his training, and certain things which seem fundamentally unsound to the technician are part of foundry tradition. The technician must locate the error and demonstrate it as an error before the practical man will enthusiastically endorse the new method.

There should be in each steel foundry fully harmonious working of foreman and superintendents who govern molding operations with steel makers or metallurgists, who govern the production of the metal. At the present time there often is a feeling of discord created when defective castings are under review,—the steel maker feels that the fault lies with the molder, and the molding foreman feels that the defects originate in some deficiency of the metal. My own experience is that in about 95 per cent

of the cases where an acrimonious discussion of such type arises, the steel is essentially satisfactory, but a broad pronouncement of that kind does nothing to make the molder feel happy. To apportion the blame is fairly easy,—to define the cause and to prescribe a remedy is often a matter of some considerable difficulty but once the cause has been found and the remedy prescribed the molder becomes an ally instead of a critic.

This brings up the question of diagnosis and here the competent foundry technician will be a great asset in the organization in that he is not primarily influenced to incline either to the molding side or to the metal side of the problem. He will, or should, go over carefully all the facts that appear to be expressed or evidenced in the defective casting or castings under review,—he will take into consideration the whole of the conditions which cover the production of the casting or castings and from the evidence he will, or should, be able to diagnose the situation properly. Correct diagnosis must precede a cure and if the cure consists in an alteration of the molding conditions, it is absolutely essential that the whole of the details be explained to the superintendent and to the foreman so that they may be apprised of the conditions which give rise to the specific form of defect under investigation. Gradually they will become acquainted with facts and with principles that appear to be fundamental and, almost unwittingly, they will begin to apply these principles in their regular procedure. It is well to have a man understand the reason for everything he does,—practice which is merely uninspired and uninformed routine does not develop the intelligence of the operative.

Instead of criticism, carping plaintive criticism, I would suggest that you have in your foundries undeveloped wealth in the men who operate in the foundries. These men labor under certain disabilities but the wealth which is in them is to some extent static and it must be translated into something dynamic by increasing their knowledge of truths in respect of foundry practice which are fundamental or which appear closely to approximate fundamentals.

Production of Malleable Is Shown

THE Malleable Iron Research institute, Cleveland, recently prepared two charts showing interesting statistics relating to the production of malleable castings in the United States during the past six years. The chart shown in Fig. 2 illustrates the approximate tonnage of malleable castings produced in the United States for the six-year period 1924-1929, based on reports of the United States department of commerce. The production for 1929 of approximately 947,000 tons is 6 per cent greater than that for 1928 and is the largest production in any year in the history of the industry except possibly that of 1923. In 1923 the department of commerce did not collect production statistics and the total for the country is estimated at about 960,000 tons on a known tonnage of about 65 per cent of the total.

The chart shown in Fig. 1 illustrates the production of malleable iron castings in the United States in percentage of plant capacity for the same 6 year period. The chart is based upon statistics released by the department of commerce and the capacity figures for the years, 1924-1927 have been revised to the basis adopted by the department beginning January, 1928. Production in relation to capacity during the first half of 1929 probably were at a higher rate of capacity than in any previous six month period in the history of the malleable iron industry. Operations for 1929 as a whole were at 72 per cent of capacity as compared with 68 per cent in 1928. Operations for the six-year period averaged only 61 per cent.

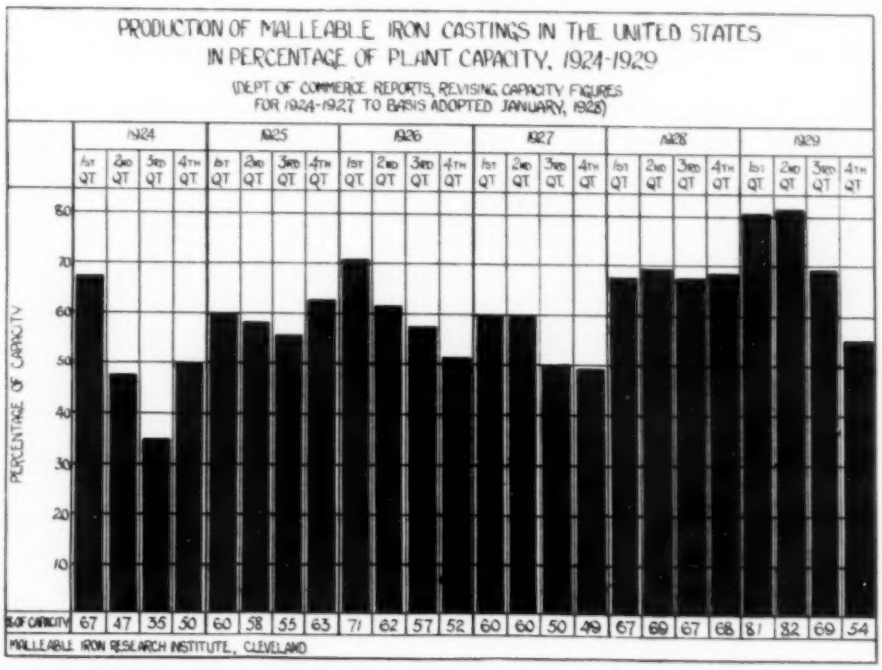


FIG. 1—TREND OF MALLEABLE CASTINGS PRODUCTION MAY BE OBSERVED IN THE QUARTERLY TOTALS BASED ON PERCENTAGE OF PLANT CAPACITY

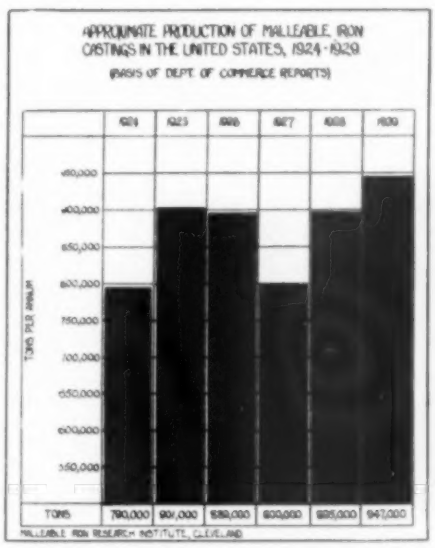

APPROXIMATE PRODUCTION OF MALLEABLE IRON CASTINGS IN THE UNITED STATES, 1924-1929
(BASIS OF DEPT OF COMMERCE REPORTS)
TONS PER ANNUM
TONS 780,000 901,000 880,000 830,000 825,000 947,000
MALLEABLE IRON RESEARCH INSTITUTE, CLEVELAND

FIG. 2—MALLEABLE CASTINGS PRODUCTION REACHED A HIGH POINT IN 1929

Publishes Bulletins

The American Refractories institute, Pittsburgh, recently has published two bulletins. One of the bulletins gives the code of ethics of the institute which has been established to eliminate unfair trade practices, unfair competition and economic waste which exist in the industry. The other gives data on the classification of modified rectangular or difficult fireclay, silica and high alumina shapes.

Bill Diagnoses Some Shrinkage Cavities

By Pat Dwyer

THROUGH close association over a period of many years I now have arrived at a stage where I can read many of Bill's thoughts and anticipate what he is going to say, with a fair degree of accuracy. I lay no claim to the possession of any supernatural powers in this respect. Without mentioning any names I know a certain person who frequently anticipates me in the same manner. She usually precedes her remarks by the statement that she knew exactly what I was going to say.

What is still more remarkable, she hits the bull's eye on an average of 99 times out of a possible 100. With all due respect to other forms of sharp shooting, I submit that is what the boys call some score.

To be perfectly frank, I must admit that in mine and Bill's case the attendant circumstances, the general atmosphere, you might say, at any given time, play an important part. We have shared so many experiences in common that a word, a gesture, an odor or a vagrant sound, usually sets the old memory cells functioning along a similar line of recollection.

After listening to a rendition of Irish airs over the radio on the night of the seventeenth—What's that? Why *the* Seventeenth of course—I knew exactly what he was thinking about even before he grinningly remarked "Tom Carrigan." These two words carried me back, as I knew they carried him back, over a period of nearly 40 years, to the night of another March 17 in the little town where we grew up. Where we contributed for several years to the uplift of music and the drama as members of the Prospect Silver Cornet Band and the Shamrock Amateur Dramatic association. With all due respect to the present 20th century dynamic methods and opportunities, we probably had more fun than the present generation with all its entertainment furnished ready to serve—out of a can!

On this particular night, recalled by the radio out of the dim mist of years, we put on that thrilling melodrama *Among the Breakers*.

In these modern days, this sterling example of the dramatist's art, probably would be captioned, *Entrails of the Great Deep*, or *The Purple Triangle*, in the preliminary stages, later changed to *Kissing in the Rain*, before the final release.

In the light of subsequent knowledge and a wider experience, I must admit that the original title was a trifle ambiguous. Conceivably the term *Among the Breakers* might refer to coal breakers, stone breakers, strike breakers, any of the various classes of law breakers, or a well known hotel on the eastern seaboard. As a matter of plain everyday fact, it referred to none of these things.

The breakers in this particular instance were part of the Atlantic ocean, lying adjacent and in close proximity to, the coast line of New England. The exact spot was not specified, but when the hired man had an *idear* that if he had a *sawr* he could cut *aout* the *patte'n*, the audience immediately knew that the scene was laid some place between Gloucester, Mass., and Calais, Me.

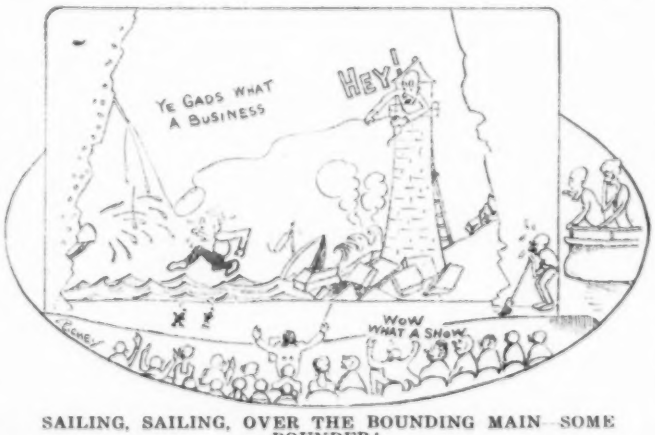
Our local artist drew freely on his imagination in painting the scenery. After all is said and done, rocky cliffs, beaches and lighthouses are pretty much all alike the world over. Our audience was no captious critic. All it wanted was action, plenty of action.

The sheet iron thunder boomed in the wings. The dried peas rattled convincingly in a wooden box studded with pegs and manipulated by a lad back stage to stimulate the swish of the waves and the driving sheets of rain, beating up against the walls and windows of the lighthouse.

In his eagerness to note the effect on the stage, the lightning maker approached too close to one of the wings and set it on fire. That little incident almost furnished a premature and unanticipated climax to the play.

The proprietor of the hall nearly collapsed while the villain, the hero and the thunder maker were engaged in extinguishing the flames. The heroine jumped out of the boat and ran nimbly over the tops of the canvas waves to safety.

However, the excitement was over in a few minutes. The show proceeded to its triumphant and happy ending with the gory death of the villain—he got just exactly what was coming to him—the lifting of the mortgage on the old farm, the complete vinidication of the hero—safe from among the breakers—and the jocund ringing of the wedding bells in the old village church. In the hub-bub of excitement and congratulations following the final curtain, every person was happy except Tom Carrigan. He was fit to be hog tied and muzzled. In a loud and impassioned voice he declared for the benefit of all and sundry, far and near, that for two pins—truly a trifling consideration—he would smash his fiddle—an heirloom in his family for over 100 years—he would smash his



SAILING, SAILING, OVER THE BOUNDING MAIN—SOME BOUNDER!

fiddle cheerfully, if he was allowed to smash it over the pianist's concrete and carroty dome. The very idea of a saucy young whelp (This is a quotation) exposing him to the ridicule of a public audience!

It served him right, he complained bitterly, for being such a fool as to take any hand, act or part with a band of young hoodlums. Never again, if he lived to be 150 years old, would he set foot on the same stage, or, if he could help it, in the same room with any of them.

(Business here of glaring around viciously, waving the fiddle above his head with one hand, and wiping foam from his lips with the other).

At that time he was a man of about 50, a positive ancient in the eyes of a gang whose ages ranged from 16 to 20. Looking back now I can sympathize with him quite heartily, but at that time I regarded the episode as a huge joke, a fitting climax to a hilarious night. Youth is heartless, even though according to our realistic modern authors it is fully equipped with other vital internal organs. Many years afterward I saw a famous Shakesperean actor in the role of old doddering, crack brained King Lear. His interpretation in voice, manner, gesture, long hair and whiskers, was magnificent, particularly in the harrowing scene where he disinherited the princess Cordelia, the youngest of his three daughters, the only one of the three who truly loved him with a daughter's love. A love so disinterested, so sincere and pure that she had no words to express it. Her silence following the oily protestations of her sisters, the arrogant Goneril and the rapacious Regan, cause the choleric old man to explode in a shower of verbal pyrotechnics. What he said to her and about her, was plenty!

He had a more fluent delivery and a more resonant voice. He employed a larger and choicer vocabulary than Tom Carrigan, but the words did not have the lash, the sting, the intensity of feeling, the real old salt-in-the-wound, the concentrated venom of Tom's on that memorable night among the breakers.

Tom with his fiddle—Pardon me, his violin—and Jack Connolly at the piano constituted the orchestra which filled in the intervals between the acts. In deference to the occasion their program was confined exclusively to familiar Irish selections.

The boys in the back rows stamped their feet enthusiastically to the lilting measures of *Garryowen*, *The Soldier's Joy*, *The Wind That Shakes the Barley* and *The Pigeon on the Gate*.

More sedate members of the audience, with many a backward glance, frowned their disapproval of this unseemly manifestation. Ushers tried to stop it. They fiercely whispered threats and maledictions. They might just as well have tried to stop the actual wind from rippling among the barley stalks on a balmy summer day. The stamping died down in one place only to break out in another.

The catastrophe happened in the musical interval before the last act. Tom played entirely by ear and naturally his rendition was given with a fine disregard of the key in which any number originally was written. His arrangement of the three items on the concluding number, *Come Back To Erin*, *The Last Rose of Summer* and *Kathleen Mavourneen*, happened to be written in the key of *D*.

THE BOYS APPLAUDED USHERS AND ACTORS IMPARTIALLY

Jack was a highly accomplished and naturally gifted pianist who could play equally well, with or without a score in front of him. He had the music of all the selections on the piano, but he cheerfully ignored the printed sheet and readily transposed the score extemporaneously when necessary to follow Tom in his straight-away race.

Everything ran along as slick and smooth as a perfectly tuned motor on the testing block. In the number before the last act a monkey wrench was dropped into the works and then the heavens fell. Fell and burst open!

Brave Jack admitted afterward that his mind wandered from the job in hand to his appearance a little later as a frisky colored gent in the last act of the play. He had to do some lively stepping to don his costume and makeup in time to meet his cue. His nimble fingers continued mechanically to pound out the melody on the keys, but unfortunately, his eyes were gazing on the score. His fingers instinctively and subconciously obeyed the message conveyed to his brain.

Come Back To Erin was written in the key of *D* and the melodies from the two instruments blended in a way that brought tears to the eyes of several old ladies in the audience.

Of course they had no intention of going back. Probably if any person attempted to send them back, they would have resisted with tooth and nail. Each one could muster a full quota of nails, but the teeth in the majority of instances were on the retired list, more for ornament than use. You might say they were reserves rather than shock troops. Some dear old ladies, and others, not quite so old, take a melancholy pleasure in the belief that they are martyrs, slaves of circumstances, puppets of fate, and therefore quite helpless. They derive the same emotional pleasures from a gentle and mushy cry as a man does from a chew of tobacco or from a long quiet drag from an old pipe.

Tom came back to Erin on a long, graceful upward stroke of the bow and then wiggled his fingers for the proper tremolo approach to the last rose l-e-ft dying a-a-lone. Jack also swung into the last rose, but his arrangement was in four flats and he pounded it out with the greatest gusto. He even worked a few extra little runs and grace notes into the thrilling passage: *No-o Ro-osebud is Ni-i-i-igh!* Tom struggled through it gallantly, but only the most heroic self restraint prevented him from plucking the red head rosebud from the piano stool and grinding him into small fragments. He put an extra savage twist into: Since the love-ly a-are sleep-ing, go slee-eep thou with them!

If looks were poisoned daggers, Jack certainly would have gone to sleep for keeps.

Only the iron clad tradition of the theater, which decrees that nothing short of actual murder will allow an actor to leave the stage during his act, kept Tom in his place while rendering *Kathleen Mavourneen*. His eyes rolled and his teeth were clinched in agony while announcing in *G* that the horn of the hunter was heard on the hill. At the same time Jack's hunter blithely was announcing the same fact in *B* flat.

Bill and I spent half an hour in reconstructing the memorable scenes of that night in the long ago and then drifted into a discussion of the later history of the various characters with whom we once were associated so intimately. Only one remains in the old town. Several, including the two musicians, long since laid down their

weary burdens and departed for a place where we trust the instruments always are in tune. Others, even as Bill and I, flew away from the old nest and became as completely lost to each other as if they never had excited. "It a funny thing," Bill remarked, "families, clubs, associations, whole communities break up and scatter to the four winds of heaven and still the old world wags along just the same. Only one thing remains constant." "And pray what," I inquired, "is that wonderful thing that remains constant in this constantly changing world?" "Trouble," Bill replied, oracularly. "Trouble, with a capital *T*. I had an inquiry from a lad the other day who was having considerable t r o u b l e with a gear blank 13 inches diameter, 2¼ inches thick on the rim. Also with a small head pulley about 6 inches diameter. The castings apparently are clean and solid leaving the mold, but shrinkage cavities are disclosed during the machining operation. In the gear blank, these cavities appear at the roots of the teeth opposite the arms. In the pulley, the hole appears above the arbor core. The pulley is cast solid except for a small recess core at one end and the center core. He had tried various systems of gates and risers without effect.

OLD TIME SONGS *JUST BEFORE THE BATTLE MOTHER!*

"A shrink hole opposite the arm in the rim of a gear blank is a common defect. It may be traced to one or more of many causes and it may be prevented by anticipating certain effects due to certain causes. I assume of course that the shrink hole is a shrink hole pure and simple and not a hole caused by gas, steam slag or sand. Holes due to these various causes present a characteristic appearance and may appear any place in the casting. The fact that the holes to which he referred only appear opposite the ends of the arms may be regarded as fairly conclusive evidence that they are shrink holes.

"Primarily these holes are due to the fact that the thickness or bulk of the rim on a blank gear is out of all proportion to the thickness of the arms and hub. It is the last part of the casting to become solid and consequently it serves as a feeder for the other parts. When its own time comes, no more liquid metal is available and the feed pockets that were drained by the arms remain unfilled.

"The ideal method of curing the trouble would be to redesign the pattern so that the rim would be the lightest and therefor the first part of the casting to become solid. However, that method is out of the question, because a hub and arms out of apparent proportion to the rim in the rough, would be too heavy altogether for the rim after the teeth were cut. The foundryman must accept conditions and patterns as they are and then take certain measures to circumvent the laws of nature.

"The most efficacious method to adopt will depend on local conditions, the size and shape of the casting, the analysis of the iron, whether the casting is made in a green or a dried mold and maybe one or two others. In this particular case I think he can cure the trouble by sticking three nails, preferably horse shoe nails with big heads into the mold at the junction of each arm with the rim. Let the nails project into the rim part of the mold so that the heads will occupy approximately the position where the shrink holes appear at present. These nails will act as internal chillers and prevent the metal from drawing away at that point. Naturally care must be observed to see that the nails are perfectly clean. A dirty or rusty nail head will produce more cavities in the rim than shrinkage.

"For his general information I outlined several other methods which are practiced to secure solid rims on blank gear wheel castings. In some instances an extra high pouring head and a number of feeders on the rim are sufficient. In others the outside of the rim is formed by an iron chill either in one part or in several sections. These chills do not *chill* the face of the casting in the ordinarily accepted foundry sense where it means all the carbon is thrown into the combined form and the iron is white. In this particular instance the analysis of the iron is regulated in the casting so that the casting simply will be densened and not chilled. In other words the iron will be machinable.

The shrink hole in the head pulley is due to the same cause and may be cured by the same remedy. However, an easier method, if it does not interfere with the utility of the casting is to place a chamber core in the center and thus secure an even distribution of metal throughout the casting.

In some instances shrink holes in castings are caused by the style of gate adopted and in others where the style of gating may be perfect, the shrinkage is caused by the speed by which the metal is driven into the mold. A low pouring head or low riser is a prolific cause of shrinkage in castings that require a little manipulation in the mold. Many castings may be poured successfully in open sand molds, or in molds under exceedingly shallow copes. These castings are uniform in cross section or otherwise designed to shrink normally and uniformly. Other castings must be treated with more care and certain precautions must be taken to insure a solid casting. "In fact," Bill concluded, "the more I think over this job, the more I am reminded of the old carpenter who claimed there were tricks in all trades but his—and he drove screws with a hammer!

Meeting Well Attended

Maj. R. A. Bull, director, Electric Steel Founders' Research group, Chicago, will address the April meeting of the Chicago Foundrymen's club at a steel castings' session on Thursday evening, April 3. The March meeting of the club was attended by about sixty who heard an illustrated talk by E. M. Handley, foundry superintendent, Chain-Belt Co., Milwaukee, on the subject, "Gating the Casting."

Mr. Handley stressed the need of educating the younger foundrymen in the art and science of proper gating and discussed his practical working formula for determining the gate and choke areas as applicable to jobbing work. He pointed out that gating tests have indicated that castings causing the least trouble conformed more nearly to the gating formula.

Officers of the Chicago club have been re-elected as follows: President, H. P. Evans, Pettibone-Mulliken Co.; vice president, R. E. Kennedy, Amer-

ican Foundrymen's association; and secretary, Albert N. Wallin, S. Obermayer Co. Directors elected are as follows: M. Sternberg, Hubbard Steel Foundry Co., East Chicago, Ind.; J. A. Marr, Chicago Steel Foundry Co., Chicago; G. P. Fisher, Burnside Steel Foundry Co., Chicago; L. E. Gilmore, Crane Co., Chicago; E. E. Griest, Chicago Railway Equipment Co., Chicago; D. G. Anderson, Western Electric Co., Chicago; P. W. Mate, Greenlee Foundry Co., Chicago; Harry Faunt, Faunt Bros. Brass Foundry, Chicago; and C. L. Cherry, Western Electric Co., Chicago.

Readers Comment

Note—Material appearing under this head does not necessarily reflect the opinion of The Foundry or of its editors.

To THE EDITORS:

I was much interested in an item which appeared in the Feb. 15 issue of THE FOUNDRY entitled, "Cracked Copper Castings." As we have had some trouble along that line I thought perhaps telling of my experience might help others who may have the same trouble. I do not believe that there should be any trouble making the castings described, regardless of whether they are made in green sand or dry sand.

We make a great many copper castings such as tuyeres, coolers and cooling plates, for open-hearth furnaces and blast furnaces of the company with which I am connected. The tuyeres and coolers made for the blast furnace are round while the coolers used in open hearths are long and flat. These castings vary in weight from 110 pounds to 700 pounds. The tuyere coolers vary in size and any that weigh between 400 pounds and 700 pounds are cast in dry sand. All the others are cast in green sand. Of course, the jacket core is dry. We use electrolytic copper purchased from one of the large metal corporations of this country and our customers want these castings as pure as possible so we use one-half of one per cent tin and about the same amount of phosphorus. The rest is pure copper pig. We had trouble once in a while with these castings cracking. Sometimes the cracks were like hairs and at other times the crack would be so large that the casting was all but broken in two. This gave us much concern, as the furnaces would be in need of these castings and at times there was danger of having to shut down the furnace for the lack of these castings. The copper was melted in an open flame furnace and we used by-product gas for fuel. The metal would come from the furnace in good shape, look clear and would not show any signs of being oxidized. The metal was melted by the same man, cores made by the same men, and molding done by the same men for years so I looked for different reasons other than our own practice.

I found that the refiners in refining copper use a green hickory pole to stir the metal during the process and if stirred too much it becomes what they call over-poled copper. I also noticed that the cracks would start with the receipt of a certain car of copper and end when it was all used.

We finally sent word to the firm supplying the copper and a man was sent to our shops to try and find out our trouble. The last time we had this trouble was about a year and a half ago. To satisfy ourselves and also the copper company, we experimented quite a bit by making a copper heat from copper taken from our warehouse and the next heat from copper taken from this car.

The copper taken from warehouse would give us 100 per cent good castings while the copper taken from the car would crack. We kept this up for two days or until we used up all the pig copper we had in the warehouse and could not furnish enough tuyeres to keep the furnace people quiet. It finally got so serious that the copper smelter trucked a load of copper from a town 200 miles away and rushed a car of other copper through for us.

We have had no trouble since but we were not able to determine what was doing it. Samples from every heat were taken and studied in the laboratory without result. The copper smelters became so convinced however, that it was the fault of the copper they sent us that they paid our company for all scrap we produced from that car, due to cracks. I believe the trouble due to over-poled copper. This seems to shorten the grain and is what I call, short grain copper. If the trouble mentioned by the inquirer in THE FOUNDRY is not due to oxidation he may be getting some of this type of copper.

ALFRED R. STONEY
National Tube Co.
Lorain, Ohio

Faked Foundry Facts

A Squeezer

Eliminates Hard Spots

To THE EDITORS:

The inquiry entitled, "Thin Castings Are Hard" which appeared in the March 1 issue of THE FOUNDRY vividly recalls a similar period of anxiety caused by the trouble referred to. The castings made by the writer's firm for fractional horsepower motors are practically the same size as those under question. The problem was the hard spot which occurred where the first iron into the mold met farthest away from the gates. The driest sand that we could run, high silicon iron and extremely hot iron failed to cure the trouble. The small cementite area appeared in 2 to 5 per cent of the castings and could not be removed by short time annealing. One day we ran out of the grade of pig iron which we had been using and substituted a pig iron made from magnetite ore which is high in titanium oxide. With this change our hard spots disappeared. The pig iron contains three or four times as much titanium as contained in the pig iron made from Lake ores. There seems

to be no other difference between the pigs. The titanium evidently retards the formation of the combined carbon. Despite an occasional run of wet sand or dull iron, we do not find hard spots.

In the course of our investigation, our only method of discovering the location of the hard spots was from the fact that the edges of the flanges would be rounded except at the point where the cementite occurred. At such points the edges would remain sharp and hard. Our analysis shows 2.50 per cent silicon, 0.075 per cent sulphur, 0.18 per cent phosphorus, and 0.60 per cent manganese. We use no foreign scrap in the mixture, and are having no trouble at the present time.

A METALLURGIST

Gray Iron Is Too Hard

TO THE EDITORS:

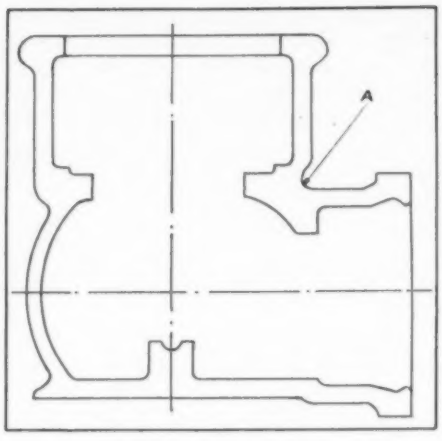
In studying the problem presented in the Jan. 15 issue entitled, "Heat Cracks Are Small," it appears to me that the inquirer is a little off in his analysis. His iron is a little too hard for enamel ware. I aim to keep the analysis as follows: Silicon, 2.25 to 2.30 per cent; sulphur, 0.05 to 0.065 per cent; phosphorus, 0.60 to 0.65 per cent and manganese, 0.50 to 0.55 per cent. The maximum limits as given should not be exceeded. This is easy enough to do if the cupola operation is watched carefully. Avoid excessive moisture in the molding sand. It should be worked as dry as possible. Four or five per cent moisture in the sand is sufficient for molding gray iron to be enameled.

H. L. WHARTON
D. A. Ebinger Sanitary Co.
Columbus, O.

Describes New Method

TO THE EDITORS:

In the Jan. 15 issue of THE FOUNDRY, page 87, I note a question and answer on the subject of a defect in a hydrant foot casting. I had this same trouble a few years ago and it was cured by ramming a perforated pipe practically in the same position occupied by the arrow in the sketch. I got the idea from a paper presented by E. V. Ronceray in Newcastle about that time. His argument was that there is no such thing as a *draw*. All the defects usually known under that term are caused by *blows* from the sand. The idea was revolutionary so far as I was concerned and in direct opposition to all foundry tradition. However, having tried every orthodox method in vain I decided to



CASTING CRACKS AT POINT *A*

give it a trial and had no more wasters on that job. On several occasions since I have utilized the same idea and it never has failed. Mr. Ronceray's argument is that when a projecting body of green sand is surrounded rapidly by molten metal the gas cannot escape quickly enough and some of it forces its way through the metal. Two of the remedies suggested in THE FOUNDRY, a core or a chill, probably will answer the purpose, but I do not favor the use of nails. They may serve to hide the defect, but I think if one were to break the casting he would find a defective area.

R. O. PATTERSON
Newcastle-on-Tyne, England

Presents Diploma to Graduate Apprentice

American Steel Foundries revised its apprentice training course in July 1927. The first apprentice to be graduated under the new regime is Robert Allen Epps, who received his diploma at a recent meeting of the foreman and apprentices of the Granite City, Ill. works of the company. Mr. Epps has been placed in charge of the sand testing laboratory.

A Correction

We regret that through an unfortunate error in the story of the Andes Foundry Co., Lancaster, Pa., in the March 15 issue of THE FOUNDRY the battery of molding machines supplied by the Moline Iron Works, Moline, Ill., was credited to another manufacturer of this type of equipment.

According to the bureau of mines publication on mineral resources, 1928, the total sales of domestic magnesium in the United States was 483,000 pounds valued at $587,000. Twelve per cent of this total or 57,960 pounds was in the form of castings.

A.S.T.M. Meets at Detroit

(*Concluded from Page* 134)

similar car using ferrous metal in its construction. The difference in weight was not entirely due to the metal parts, but also may be ascribed to saving in weight of tires, lighter springs, etc. The largest use of aluminum in automotive service today is in pistons. Practically 70 per cent of American automobiles use aluminum pistons. New alloys have been developed which decrease the difference in expansion under heat which normally is encountered in comparing iron and aluminum. The present-day demand for quality and performance again is turning attention to the use of aluminum in automotive service.

Automobile bearing metals requiring a proper mixture of hard and soft constituents were reviewed by Clair Upthegrove, University of Michigan, Ann Arbor. These are classified as tin base, lead base, copper base, zinc base, aluminum base and magnesium base with the addition of the so-called oilless bearing metals which carry a lubricating constituent. Various types of bearings were recommended for the different classes of service encountered.

In commenting on this paper A. L. Boegehold described a test where a single-constituent bearing metal, pure tin, showed superior properties in a 1-inch diameter bushing operated on a 150-hour wear test in comparison with babbit and other dual metals.

C. F. Kettering, general director, research section, General Motors Corp., Detroit, acted as toastmaster at the dinner held Wednesday evening. President Lynch reviewed briefly the aims and objects of the American Society for Testing Materials. He noted that tests must be simple, commercial and easily understood by both producers and users. The growth of the society and the value of its service is reflected in the fact that at its establishment in 1902 the membership list totaled 129 while today it is in excess of 4400. R. G. Guthrie, chief metallurgist, Peoples Gas, Light & Coke Co., Chicago, and president, American Society for Steel Treating, spoke on the value of technical societies as insurance and as an aid to progress.

An interesting demonstration of audible light was presented by John Bellamy Taylor, research laboratory, General Electric Co., Schenectady.

E. J. Byerlein, general manager, Milwaukee Foundry Equipment Co., Milwaukee, sailed from San Francisco, Feb. 19, for a trip around the world which will take approximately six months.

¶ Like Other Spectacular Achievements Usually Credited To Flashes of Genius, A Method of Cleaning Windows Was Developed Through a Mere Oversight, A Technical Error

Reveals a Way To Light *the Foundry Floor*

By James A. Murphy

AMONG the good things ushered into our industrial life by the twentieth century is the modern foundry with plenty of light. Indeed some of them are veritable glass houses. The problem that came with the design and still is coming, is how to keep this glass clean. To allow the rays of old Sol to reach the foundry floor to assist the molder in the performance of his onerous duties.

After a few years without attention some of these foundries presented a sorry sight. Your deponent is not prepared to say whether pure carelessness, force of ancient habits, or bogus economy is responsible for the dirt, but even if he did say it would not alter the results in the case to the slightest extent.

Was Mechanically Perfect

In one of these foundries the exuberant owners throught all they had to do to get castings of any one particular kind or quantity was to press a button in the office. Presto! The required castings without hindrance or obstruction would be landed at the predetermined point of delivery. Every modern appliance that by any stretch of the imagination could be considered at all applicable to their work was installed. Nothing of a mechanical nature was neglected. Everything was perfect on paper. The shop was considered so nearly automatic and its various functions so well synchronized that little if any thought or attention was given to the human element. Indeed this feature was considered just a minor necessary evil. A few men would be there to man the corners, so to speak, and they should be cheap.

When the wonderful machine was placed in operation the owners had a rude awakening, so rude that they did not sleep soundly for years. The jingle of lost coin awakened the latent philosophy of another jingle: *For want of a nail the shoe was lost etc.*, to read: *For want of a man the shop was lost.* Before they arrived at the wise decision to find the best man possible for the job in hand, treat him well and pay him well, they had 57 varieties of foremen and 57 varieties of bad castings and probably more than 57 varieties of causes therefor.

Finally the company engaged an able superintendent but I suppose on the principle that a burned child dreads the fire, they decided not to trust him entirely. They assigned him as an assistant, one of these splendidly plumaged birds of passage known as an efficiency expert.

As a preliminary measure the new boss ordered the windows cleaned. He wanted more light on the subject and he insisted if for no other reason than to save the terrific electric light bill that burdened operation month after month.

This window cleaning job was no cinch. A great deal of oil was burned in core and other ovens and an oily carbon deposit on the glass defied the ordinary methods of cleaning. The job was put to the *E. E.* and he entered into negotiations with a firm in another city that made a specialty of such work.

Discovers an Error

While the bargaining for the job was going on the ferret discovered a glaring error. One of the precious links was missing from the perfect mechanical chain. The cupola had no drag to pull out the bottom when it was dropped. It had to be picked apart, often while quite hot and carried to the dump in wheelbarrows. To say the least this did not speak well for such an up-to-date shop. A cupola drag is simple and inexpensive and no shop should be without one if it can be used. However, while it is simple and inexpensive, it must be made in the correct manner and according to proper specifications.

With a vision of laying off the wheelbarrow chauffeurs the *Expert* save the mark, conceived the idea of providing a tight steel box, big enough to hold the complete drop from a 66-inch cupola. Handles were attached by which it might be pulled out with one swing by the crane, landed on a car and pushed to the dump. Fine, says the reader. Fine indeed, but the best laid plans of mice, men and efficiency experts gang aft aglee and, as they say in the foundry—a damsite further.

No person ever learned who was responsible for the order but someone either a bright member of the cupola gang or the efficiency expert himself poured a few inches of water in the box drag under the cupola. It may have been done accidentally, or perhaps with the idea of quickly cooling the bottom, killing two birds with one stone.

Idea Works Too Well

If that was the idea it worked only too well and too rapidly. Usually when the bottom is dropped the material falls to the floor or drag and after a little squirming stays there as long as it is left. This particular bottom did not stay quiet. It shot out and up like a million cannon crackers and disintegrated to such an extent that it disappeared, flew away, vanished entirely leaving only a Zip! Boom! in its wake.

Fortunately no lives were lost, nor was anyone injured seriously. The explosion performed one service efficiently, quicker and better than any efficiency expert ever performed before or since. It whipped every last dirty window light out of the building.

The lighting problem in this case was solved as quickly as it was on another memorable occasion when it followed the command "Let there be light." There was plenty this time.

The Shakeout

DAN M. AVEY, *Editor*
FRANK G. STEINEBACH, *Managing Editor*
PAT DWYER, *Engineering Editor*
EDWIN BREMER, *Metallurgical Editor*
CHARLES VICKERS, *Nonferrous Editor*
NORMAN F. HINDLE, *Assistant Editor*

¶ Perpetuating Ignorance

AN HONEST mistake may be forgiven, but dumb ignorance, masquerading as smart wisdom, lies beyond the limit of that divine attribute. Occasionally, local papers in a burst of civic pride send a callow reporter to write a story about a leading foundry of the locality. The result often is weird and wonderful to behold. Pat Dwyer's philosophical friend, Bill, has commented from time to time upon the valor of these attempts at dramatization, and Cartoonist Richey has found much humor in the items from the daily press describing foundry operations. These slips of the newspaper fraternity may be forgiven. In fact some of the most outrageous stories may have been inspired by a pranking foundryman.

NOW comes a ponderous and beautifully executed periodical with the announced mission of interpreting industry to the laymen masses. Perhaps to the classes would be the more accurate designation of the clientele of this magazine, since the subscription price is no mean figure, and the list of readers, displayed with pride, accents the momentary holders of the world's news spotlight. This periodical, investigating a midwestern industrial center, depicts an automotive foundry in one of its leading articles. The illustrations taken from odd positions are weirdly labeled to show pouring iron from *buckets*, making sand cores for *crankshafts* and similar light pastimes of an automotive foundry, but this gem of complacent ignorance may be judged from the following:

> At least half of all industry depends upon the foundry and the forge, i. e., the blacksmith shop. The foundry is about 20 acres under a roof held up by a forest of pillars. Along one side will be a row of brick ovens as big as cottages. Out of them stick spouts like bigger and stiffer elephants' trunks. From the spouts a stream of gold-red molten iron flows rapidly into a big bucket. When the bucket is filled, the stream is shut off and the bucket disappears down the lane, being carried by an overhead trolley which takes with it a couple of half-seen men in a kind of side-car contraption . . . The brawny men walk away with their ladles, which have very long handles. They walk through rows and rows of mud pies. They are not really mud pies, but neatly constructed sand molds with a hole at the top. Into these holes the brawny men empty their ladles, and then something is almost made; a crankshaft or an axle or the base of a plow or the leg of a sewing machine. Wherever it is, the foundry always looks, or rather *feels*, the same. It is heavy, not so much with smoke as with darkness. The darkness smells of decomposing substances: coal oil, molasses water, corn flour and sea coal. It does not terrify, it numbs; you cannot remember green . . .

And later

> . . . We take handfuls of sand and put it into the forms. Then we pat it. Then, deftly, we scatter a little extra sand here and there. Then we smack the two halves of the sand-filled forms together, remove the forms, and, lo, we have a crankshaft of sand. Actually, what we have made represents the hollow inside part of the crankshaft, for what we have made is the core—the hole in the doughnut.

SHADES of Hiram, Vulcan and Cellini! Were ever such artificers in metal known in the planetary system? More of the same character follows, making the article unique in the long experience of THE FOUNDRY'S editorial staff. It might be amusing; it might be forgiven as an error committed by a young daily newspaper reporter, but in the dignity of its presentation carrying the stamp of a reputable publishing house, it carries too much authority to be overlooked. Such abysmal ignorance of foundry processes is a mark of distinction that only disgusts. Probably the writer was steeped in the artistic frenzy too deeply to appreciate an orderly, clean, bright plant, just as he—or was it a she—failed to register a single fact worthy of credence in the entire article. We can't forgive. We can only pity.

¶ One To Go

STANDARDIZATION of cost systems for various classifications of the foundry industry has received considerable attention in recent years. Cost meetings have featured the annual conventions of the American Foundrymen's association. Numerous associations have studied the subject in detail and have developed unified systems designed to meet their particular needs. A suggested classification was prepared by the Southern Metal Trades association several years ago. The Malleable Iron Research institute has had a standardized system for several years, the Gray Iron institute introduced one for that industry in January of this year and the Steel Founders Society of America is studying the problem and probably will have its system completed within a few months. Only action from the nonferrous foundry field is necessary to make foundry industry unanimous on standardized costs.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

C. R. MESSINGER, since 1909 associated with the Sivyer Steel Casting Co., Milwaukee, and formerly president of that company, has been elected chairman of the board of directors following the absorption of the Nugent Steel Casting Co., Chicago. Mr. Messinger was graduated from Sheffield Scientific school, Yale university, New Haven, Conn., in 1906. Following graduation, he became representative for the Harbison-Walker Refractories Co., Pittsburgh, in that city and later in Chicago. He was appointed general manager of the Sivyer Steel Casting Co., Milwaukee, in 1909 and later was made vice president. In 1916, Mr. Messinger was appointed secretary of the Federal Malleable Co., Milwaukee. He was appointed general manager of the Chain Belt Co., Milwaukee, in 1917. He went to Europe in 1919 to establish direct export connections for the companies that he represented. In addition to his connections already mentioned, Mr. Messinger is a director and officer of many banks, banking institutions and other companies. He has been active in trade association and technical society work. His work in connection with the American Foundrymen's association brought him the presidency of that association in 1922. He also has been active in the Milwaukee Metal Trades association, Electric Steel Founders Research group and the American Malleable Casting association now known as the Malleable Iron Research institute.

T. Hill has been appointed sales manager of the Detroit Gray Iron Foundry Co., Detroit.

Charles M. Brooks, associated with the Lebanon Steel Foundry, Lebanon, Pa., for the past 4 years, has been appointed purchasing agent to succeed S. Gingerich.

Leo Weaver, assistant to the president of the Schill Bros. Co., Crestline, O., has resigned to become manager of the Lewisburg Foundry Co., Lewisburg, Tenn.

George Castor, formerly vice president of the Donaldson Iron Co., Emaus, Pa., has been elected president. He succeeds J. G. Eberlein, resigned, who has been connected with the company for 46 years.

R. G. Palmer and James D. Coltman addressed the University club, Cleveland, recently on foundry subjects. Mr. Palmer's subject was "The Story of Iron from the Mine to the Foundry" and Mr. Coltman spoke on "The Most Modern Methods of Foundry Practice."

E. R. Bishop has been elected president of Globe Forge & Foundries Inc., Syracuse, succeeding the late W. Charles Lipe. Mr. Bishop was formerly vice president and treasurer of the company. F. W. Strickler is secretary and treasurer. E. Lawton Bishop is purchasing agent.

C. R. MESSINGER

Ivan L. Johnson, superintendent, Best Steel Casting Co., Oakland, Calif., has been appointed chairman of a committee to handle the local arrangements for the second biennial National Western Metal congress to be held in the Civic auditorium, San Francisco, Feb. 16 to 20, 1931.

Fred Erb and N. K. B. Patch, president and vice president of the American Foundrymen's association respectively, will represent that organization at the fiftieth anniversary celebration of the American Society of Mechanical engineers to be held in New York, Hoboken, N. J., and Washington April 5 to 9.

F. A. Lorenz Jr., assistant vice president in charge of operations, American Steel Foundries, Chicago, has been appointed general manager of both Indiana Harbor and Pittsburgh works, in charge of sales and production. He formerly was manager of sales, Davis wheel division; assistant to the fourth vice president; works manager, Indiana Harbor works; and then assistant vice president in charge of operations.

Louis B. Graham, formerly in charge of the core room, Frank Foundries Corp., Moline, Ill., has accepted a position as core room foreman, Oliver Farm Equipment Co., Hart-Parr division, Charles City, Iowa. Mr. Graham served his apprenticeship with the Falk Corp., Milwaukee. He left the employ of that company in 1926 to become associated with the Frank Foundries Corp., Moline, Ill. He served in various capacities finally being placed in charge of the core room.

H. R. Brest, secretary and treasurer of the Pettibone Mulliken Co., Chicago, maker of railroad track supplies, has been elected a member of the board of directors. Two other new members are John Fletcher, of John Burnham & Co., Chicago, and William C. Cook, vice president of the Central Trust Co. of Illinois, Chicago. These directors succeed R. C. Fenner, Joshua D'Esposito, and F. A. Thulin, resigned. George R. Lyman was elected a vice president. Other directors and officers were re-elected.

O. W. Ellis, director and metallurgical research engineer, Ontario Research foundation, Toronto, Canada, addressed the Philadelphia Foundrymen's association at its meeting on March 12 at the Manufacturers' club, Philadelphia. Mr. Ellis formerly was assistant professor of metallurgical engineering of the University of Toronto, leaving Toronto to accept the appointment of industrial fellow at the Mellon Institute of Industrial Research, University of Pittsburgh. He discussed high strength brasses.

Charles F. Frede, Commonwealth division of the General Steel Castings Corp., St. Louis, has been made works manager. He first was assistant chief engineer in charge of the drafting room but since 1918 has had charge of production. Harry E. Rogers, superintendent of the finishing department, has been made assistant to Mr. Frede. Harry Thiele, formerly superintendent of the pattern department, is now superintendent of the core and found-

ry departments. Earl F. Varnum, associated with the company for the past 20 years, has been appointed assistant to Harrison Hoblitzelle, vice president and general manager. Gilbert F. Close, formerly assistant to the president, now is director of relations.

Isaac W. Frank, chairman of the executive committee and director, United Engineering & Foundry Co., Pittsburgh, recently celebrated his seventy-fifth birthday and his fifty-fourth year in industry. Mr. Frank was born Dec. 2, 1855, and confined the sphere of his business career to the Pittsburgh district. He attended Western University of Pennsylvania, Pittsburgh, and was graduated in 1876 from Rensselaer Polytechnic institute, Troy, N. Y., with a degree in civil engineering. Mr. Frank's initial employment was as a draftsman with the Keystone Bridge Co., Pittsburgh. In 1879 and 1880 Mr. Frank was active in mining and mine surveying at Leadville, Colo., and then returned to Pittsburgh to give his attention to the manufacture of rolls, rolling mills and steelworks machinery. During

ISAAC W. FRANK

this early period he was both secretary and engineer of the Lewis Foundry & Machine Co., Pittsburgh. The organization which later led to the formation of the United Engineering & Foundry Co. had its inception in 1892 when Mr. Frank was instrumental in the establishment of the Frank-Kneeland Machine Co. Nine years later upon the formation of the United Engineering & Foundry Co., a consolidation of four manufacturers of rolls and rolling mill equipment in the Pittsburgh district, Mr. Frank became its first president. He retired in 1919 and at present is chairman of the executive committee and a director. He is an officer and director of many companies and is interested in educational and philanthropic matters. He also is a past president of the Pittsburgh Foundrymen's association.

Franklin Farrel Jr., formerly vice president of the Farrel-Birmingham Co. Inc., Ansonia, Conn., manufacturer of chilled rolls, heavy machinery, etc., was elected chairman of the board of directors at the recent annual meeting. N. W. Pickering was elected president to succeed Walter Perry, who has retired after 41 years of service with that company and its predecessor, the Farrel Foundry & Machine Co. D. R. Bowen, chief en-

Foundry Association Directory

American Foundrymen's Association

President, FRED ERB, Erb-Joyce Foundry Co., General Motors building, Detroit; executive secretary-treasurer, C. E. HOYT, 222 West Adams street, Chicago; technical secretary, R. E. KENNEDY, 222 West Adams street, Chicago.

Associated Brass Founders of New England

President, GEORGE W. THORNBURG, Crescent Park Brass Foundry, Watham, Mass.; secretary, R. B. BONNER, Somerville Machine & Foundry Co., 14 Kent street, Somerville, Mass. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. MCARTHUR, Washington Iron Works; secretary, W. J. WARK, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. HIRE, Hire Foundry Co., Peoria, Ill.; secretary, FRANKLIN WHITEHEAD, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, H. P. EVANS, Pettibone-Mulliken Co.; secretary, ALBERT N. WALLIN, S. Obermayer Co., 2563 West Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, CARL S. NEUMANN, Union Mfg. Co., New Britain, Conn.; secretary, CHARLES S. PARKER, Charles Parker Co., Meriden, Conn. Meetings are on second Friday of each month in various parts of the state.

Detroit Foundrymen's Association

President RUSSELL M. SCOTT, Packard Motor Car Co., Detroit; secretary, WILLIAM J. MUHLITNER, Great Lakes Foundry Sand Co., 2100 Penobscot building, Detroit. Meetings third Thursday in each month except December, June, July and August at Masonic temple.

East Bay Foundrymen's Association

Secretary O. R. MOLLER, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Electric Steel Founders' Research Group

Director, R. A. BULL, Assistant Director, C. N. RING; Central Office, 541 Diversey Parkway, Chicago.

Gray Iron Institute

President, WALTER L. SEELBACH, Forest City-Walworth Run Foundries Co., Cleveland; secretary, ARTHUR J. TUSCANY, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, R. R. FAUNTLEROY, Moline Malleable Iron Co., St. Charles, Ill.; secretary, ROBERT E. BELT, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, WILLIAM EMBER, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, WILLIAM E. PAULSON, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue, New York.

Newark Foundrymen's Association

President, J. L. CARTER, Sachs-Barlow Foundries, Inc., Newark; secretary, W. H. MANTZ, Atlas Foundry Co., Irvington, N. J. Meeting called by president.

New England Foundrymen's Association

President, ERNEST F. STOCKWELL, Barbour-Stockwell Co., Cambridge, Mass.; secretary FRED F. STOCKWELL, 205 Broadway, Cambridgeport, Mass. Meetings second Wednesday of each month at the Exchange club, Boston. Outings usually are held in the summer months.

Ohio Foundries Association Inc.

President, DON MCDANIEL, Hamilton Foundry & Machine Co., Hamilton, O.; secretary-manager, E. F. SCOTT, 418 Penton building, Cleveland.

Pacific Coast Founders Association

President, CHARLES J. P. HOEHN, Enterprise Foundry Co., 2902 Nineteenth street, San Francisco; manager, S. M. TRUITT, 55 New Montgomery street, San Francisco.

Philadelphia Foundrymen's Association

President, C. F. HOPKINS, Ajax Metal Co., Philadelphia; secretary, EARL SPARKS, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Pittsburgh Foundrymen's Association

President, L. W. MESTA, Mesta Machine Co., Homestead, Pa.; secretary-treasurer, WILLIAM J. BRANT, Wm. J. Brant, Bessemer building, Pittsburgh. Meeting on the third Monday of the month, except in July and August at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, F. W. KIRBY, John Deere Spreader Works, East Moline, Ill.; secretary-treasurer, J. P. BOADEN, Union Malleable Iron Co., East Moline, Ill. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

St. Louis District Foundrymen's Club

President, HORACE R. CULLING, Carondelet Foundry Co., St. Louis; secretary-treasurer, LEO J. FILSTEAD, John C. Kupferle Foundry Co., St. Louis.

Southern Metal Trades Association

President, JOHN S. SCHOFIELD, J. S. Schofield's Sons Co., Macon, Ga.; secretary, W. E. DUNN JR., Flatiron building, Atlanta, Ga.

Steel Castings Development Bureau

Research Director, GEORGE BATTY, 500 Stock Exchange building, Philadelphia.

Steel Founders' Society of America

President, J. E. MCCAULEY, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.; managing director, G. P. ROGERS, Graybar building, New York. Meetings: Cleveland, May 12-15, 1930.

Tri-City Technical Council

Chairman, C. F. SCHERER, Davenport Machine & Foundry Co., Davenport, Iowa; secretary, E. C. XANDER, assistant secretary, Tri-City Manufacturers association, Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, WILLIAM HOPPENJANZ, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, C. C. ERHART, Chris Erhart Foundry Co., Cincinnati. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, WILLIAM J. SNYKER, St. Paul Foundry Co., St. Paul; secretary-treasurer, C. E. LANGDON, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club

President, J. W. ORPHAN, Lake Union Foundry Co., 1703 Westlake avenue, Seattle; secretary, EDWARD C. GUSTIN, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Western Foundrymen's Association

President, H. T. HORNSBY, Joplin, Mo.; secretary, E. L. GRAHAM, Acme Foundry & Machine Co., Coffeyville, Kans.

Wisconsin Gray Iron Foundry Group

Secretary, W. F. BORNFLETH, Cutler-Hammer Inc., Foundry Division, Milwaukee. Meetings on first Wednesday of each month at Hotel Schroeder, Milwaukee.

gineer, Carl Hitchcock, formerly assistant secretary, Franklin R. Hoadley, manager of foundries, and A. G. Kessler, manager of the Buffalo division, were elected vice presidents. The following officers were re-elected: Alton Farrel, treasurer; G. C. Bryant, secretary; F. M. Drew Jr. and L. K. Blackman, assistant treasurers and W. B. Marvin, assistant secretary.

Tells Detroit Founders Facts on Iron

A. L. Boegehold, General Motors Corp., Detroit, was the principal speaker at the March 20 meeting of the Detroit Foundrymen's association. Mr. Boegehold reviewed the effect upon casting quality of various factors in blast furnace operation. Russell Scott, foundry manager, Packard Motor Car Co., Detroit, president of the association, presided and introduced Fred Erb, Erb-Joyce Foundry Co., president, American Foundrymen's association, who spoke briefly of the forthcoming convention. More than 75 were in attendance, according to W. J. Muhlitner, Great Lakes Foundry Sand Co., secretary of the Detroit group. Out-of-town visitors at the session who spoke briefly included R. S. MacPherran, Allis-Chalmers Co.; J. W. Bolton, Lunkenheimer Co.; J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham; and Dan M. Avey, THE FOUNDRY, Cleveland.

Pittsburgh Foundrymen Hear Walton

Albert Walton, consulting engineer, United Engineering & Foundry Co., Pittsburgh, addressed the Pittsburgh Foundrymen's association at its monthly meeting held March 17 at the Fort Pitt hotel, on "Foundry Practice, Its Relation to Profits." Mr. Walton discussed the opportunities for reduction in operating costs in various phases of foundry practice. He emphasized particularly the desirability of maintaining accurate records of costs. Nearly 100 members of the Pittsburgh group attended the meeting.

Moves Chicago Office

Whiting Corp., Harvey, Ill., has moved its Chicago sales office from 80 East Jackson boulevard to suite 1186 Civic Opera building, 20 North Wacker drive. The Chicago office staff consists of Robert S. Hammond, district manager; L. D. Reed and G. M. Dennis, sales engineers; Joseph Harrington, president of the Harrington division; and Jeff Corydon, sales engineer of the Harrington division.

Ohio Founders Postpone April Meeting

The sectional meeting of the Ohio Founders Association Inc., scheduled for April 16 at Cleveland, has been postponed. Members will be advised concerning the new date for the meeting.

Enlarges Staff

Cyril Ainsworth, formerly director, bureau of industrial standards, Pennsylvania department of labor and industry, has been appointed to direct the national safety code work of the American Standards association, 29 West Thirty-ninth street, New York. Mr. Ainsworth has had eight years' experience in that work and will direct the establishment of national codes for guidance of state and municipal governments, industrial organizations and insurance companies.

The association also has appointed John Wilson McNair, formerly of the standards department of the American Society of Electrical Engineers, and Clarence Edward Darling, formerly of the American Society of Mechanical Engineers, to its staff. Mr. McNair will handle electrical standardization projects while Mr. Darling will devote his efforts to mechanical and chemical standards.

Loom Works Elects

Crompton & Nowles Loom Works, Worcester, Mass., has re-elected officers as follows: President, Dr. Homer Gage; vice president and general manager, John F. Tinsley; vice presidents, Frederic W. Howe, and Irving H. Verry; treasurer, Edward F. Green; assistant treasurer, Fred J. Bowen; clerk, John B. Syme; attorney, Charles M. Thayer. Directors are: Sydenham B. Alexander, Charlotte, N. C.; Fred J. Bowen, George Crompton, Rufus S. Frost, Dr. Gage, T. Hovey Gage, Albert A. Gordon, Mr. Green, Mr. Howe, Frank P. Knowles, Henry F. Phelps, Philadelphia; Pierpont L. Stackpole, Boston; Mr. Syme, Mr. Thayer, Mr. Tinsley, Mr. Verry and George E. Warren, Boston. The executive committee is: Mr. Frost, Dr. Gage, Mr. Green, Mr. Howe, Mr. Knowles, Mr. Stackpole, Mr. Tinsley, Mr. Verry, Mr. Warren.

Six Foundry Employes Win Diplomas

WAUKEGAN FOUNDRY CO., North Chicago, Ill., recently honored six graduates of McLain's System Inc., at a banquet in the offices of the company. David McLain, guest of honor, presented the diplomas. The class consisted of production manager, superintendent, foundry foreman, core foreman, patternmaker and melter.

A. K. Barr, president, and a McLain graduate of 1920, conducted the work of the class, which covered a period of 26 weeks, two evening classes being held weekly. He claims that it has been one of the greatest pleasures of his life to work with the men and to note the pride each has taken in his work in the class and the increased interest in his foundry work. There are now eight graduates in the organization. Mr. Barr believes that the work of the class has resulted in an increase in efficiency and production and an improvement in quality.

(UPPER ROW) MARTIN BENA, MICHAEL PETKUS, ROBERT BARR, ROBERT KAPHEIM, WILLIAM BENOIT (LOWER ROW) A. K. BARR, DAVID McLAIN, WILLIAM ROMAN

Trade Trends in Tabloid

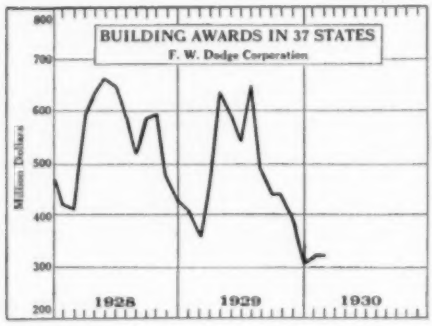
CASTING specifications for the Continental Motor Co., released on March 15 and effective during the last of March and April, are reported to be the largest since July 1929.

—T—T—

General jobbing foundries in the Detroit district, exclusive of those devoted to the automotive trade, are operating profitably at about 60 per cent.

—T—T—

Several large stove manufacturers in the St. Louis district have started



full time operations earlier this season. Increased activity in jobbing foundries and a higher rate at the farm implement and machinery shops also is reported.

—T—T—

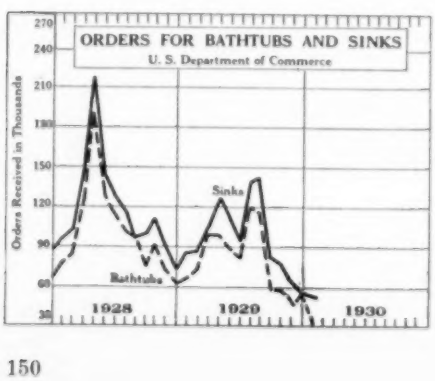
The volume of pig iron business booked for second quarter throughout the country showed a substantial increase during the last half of March.

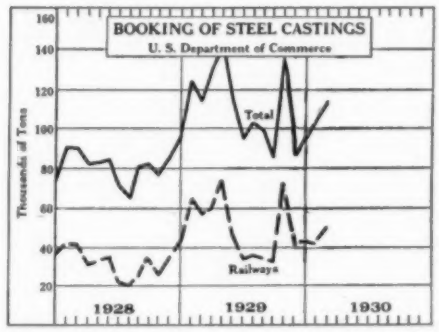
—T—T—

Bookings of steel castings in February totaled 79 per cent of plant capacity, as compared with 70 per cent in January and 79 per cent in February, 1929. Approximately one hundred fifteen thousand tons were booked and one hundred seven thousand tons were produced in February.

—T—T—

While public utility buying of cast iron pipe has proved disappointing thus far this season, private orders have been more extensive than was





the case a year ago. Municipal buying is improving.

—T—T—

Farm implement and tractor builders in the Chicago and Milwaukee districts are buying considerable pig iron. Inquiries are increasing. Reduction in tractor prices recently were made by one leading manufacturer.

—T—T—

Malleable casting production gained in February, according to the department of commerce. The total for the second month of the year was 66,024 tons compared with 61,145 tons for January. Operations averaged 67.4 per cent of capacity.

—T—T—

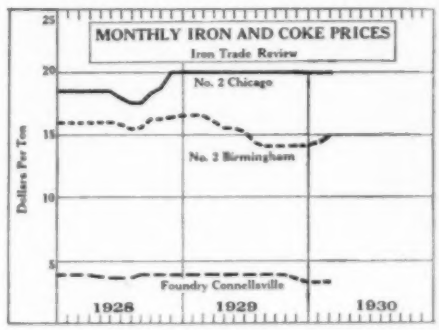
Evidence of an upturn in building activity is revealed by the number of awards for industrial and commercial buildings recently received by the Austin Co., Cleveland. That company also reports inquiries increasing.

—T—T—

American Telephone & Telegraph Co. will spend approximately one hundred and six million dollars for 1930 construction activities.

—T—T—

Operations at railway car plants are increasing and shipments in March probably will show the best record since May of last year. The marked falling off in bookings in March probably will not affect the situation, since



it usually takes from two to three months for orders to get into the production stage.

—T—T—

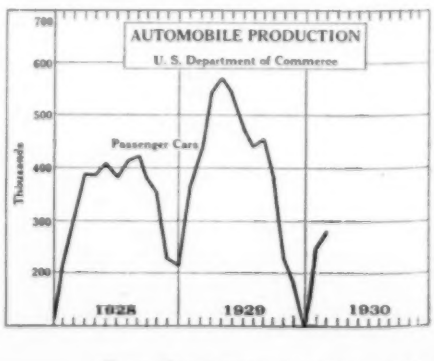
Automobile production in February totaled 288,854 passenger units as compared with 243,955 in January, a gain of approximately thirty-nine per cent. Schedules gradually are being increased but it is doubtful if the March total will exceed the February output.

—T—T—

Combined deliveries of brass and bronze ingots and billets by members of the Nonferrous Metal institute increased 744 tons or 12.1 per cent during February.

—T—T—

Foundry operations in New England improved during March and foundrymen are optimistic regarding developments in the next few months.



RAW MATERIAL PRICES

March 22, 1930

Iron	
No. 2 foundry, Valley	$18.50
No. 2 Southern, Birmingham	14.00
No. 2 foundry, Chicago	19.50
No. 2 foundry, Philadelphia	20.26 to 20.75
No. 2 foundry, Buffalo	18.50
Basic, valley	18.50
Basic, Buffalo	18.00
Malleable, Chicago	19.50
Malleable, Buffalo	19.00
Coke	
Connellsville beehive coke	$3.50 to 4.85
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	9.00
Scrap	
Heavy melting steel, Valley	$16.00 to 16.50
Heavy melting steel, Pitts	16.25 to 16.75
Heavy melting steel, Chicago	13.25 to 13.75
Stove plate, Buffalo	12.50 to 12.75
Stove plate, Chicago	11.00 to 11.50
No. 1 cast, New York	10.85
No. 1 cast, Chicago	14.00 to 14.50
No. 1 cast, Philadelphia	15.50 to 16.00
No. 1 cast, Pittsburgh	14.50 to 15.50
No. 1 cast, Birmingham	10.00 to 11.00
Car wheels, iron, Pittsburgh	14.50 to 15.00
Car wheels, iron, Chicago	14.50 to 15.00
Railroad malleable, Chicago	16.50 to 17.00
Agricultural mal., Chicago	14.75 to 15.25
Malleable, Buffalo	17.00 to 17.50
Nonferrous Metals	**Cents per pound**
Casting, copper, refinery	17.25 to 17.37½
Electro, copper, producers	18.00
Straits, tin	37.00 to 37.12½
Lead, New York	5.50
Antimony, New York	7.87½
Nickel, electro	35.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	16.00 to 16.50
Zinc, East St. Louis, Ill.	4.87½ to 4.90

Obituary

James V. McCrae, research associate for the Steel Castings Development bureau, bureau of standards, died March 5. Mr. McCrae, was born in Grimsby, Can., and attended the public schools of McKeesport, Pa. He also spent two years at Carnegie Institute of Technology, Pittsburgh. He was employed by the National Tube Co., McKeesport, Pa., in various capacities from 1897 to 1902 and from 1902 to 1903 was associated with

JAMES V. McCRAE

the Port View Tin Plate Mills and the Woods' Sheet Mill, McKeesport. He was associated with G. A. McKenna in various capacities in different plants from 1903 to 1919. From 1903 to 1909, he was employed in the laboratory of the Firth Sterling Steel Co. and during part of 1909 and 1910 was in the chemical laboratories of the Colorado Fuel & Iron Co., at the Pueblo and Sunrise, Wyo., works. During the period from 1910 to 1913 he was in charge of operations at the Wolf Tongue Mining Co., Nederland, Colo., and later became assistant chemist of the Washington Steel & Ordnance Co., Washington. Soon after he went to Washington and until 1919, he was superintendent of the Chemical Products Co. He was assistant chief chemist at the Philadelphia works of the Henry Disston Sons from August, 1920 until April 1926. Subsequently, he became chief chemist at the Dodge Steel Co., Philadelphia. For the past two years, he has been research associate at the bureau of standards for the Steel Castings development bureau.

Frank Paul Johness, 70 years old, owner of the North Side Foundry Co., Columbus, O., died of heart disease at his home in Columbus recently.

John W. Jiles, 67 years old, president of the James Jiles Sand Co., Pittsburgh, died recently in that city. The Jiles company, which was founded in 1864 by his father, James Jiles, handles molding sand.

William J. Longmore, consulting purchasing agent, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., died March 4 at his home in Bellevue, Pa. He had been connected with the Westinghouse company since 1886.

James R. Harris, 56 years old, vice president and general manager of the Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, died at his home in that city March 12 after an illness of a year. Mr. Harris had been associated with the Busch-Sulzer interests since 1909.

Jacob H. Weisbrod, 50 years old, assistant vice president of the American Car & Foundry Co., New York, died of pneumonia March 7 at his home in Brooklyn. He started his career with the American Car & Foundry Co. 27 years ago as a draftsman.

William N. Kuhns, 72 years old, president of the Kuhns Bros. Co., Dayton, O., manufacturers of cast iron fittings, died recently after a brief illness. He was one of the oldest foundrymen in that district. His first business connection was with the Stoddard Mfg. Co., Dayton. In 1888 he went into the foundry business with his brothers and established the Kuhns Bros. foundry of which he was president at the time of his death.

Daniel J. Cullinan, aged 78, pioneer iron manufacturer, died March 4 in his home in Pittsburgh. He was born in Ireland and early in his career engaged in prospecting and mining in Australia. He came to America and settled in Cleveland where he founded the Forest City Malleable Iron Works. This firm later consolidated with the McConway-Torley Co., Pittsburgh. In 1893 Mr. Cullinan helped organize the Western Foundry Co. of Chicago.

Charles Leonard Newcomb, formerly connected with the Worthington Pump & Machinery Corp., at the Dean works Holyoke, Mass., died at his home March 13. He was graduated from Worcester Polytechnic institute in 1880 with a degree in mechanical engineering. The following year he became superintendent for the Dean Steam Pump Co., Holyoke, Mass. He rose to presidency and general managership of that company and retained the latter position when the company was merged with the Worthington company, retiring in 1927, after he had been connected with the company for 46 years. He was extremely active in trade organization work and was one of the moving spirits in the formation of the National Founders association and the National Metal Trades association. He served as the first vice president of both organizations. He also was a past president of the New England Foundrymen's association and was elected a vice president of the American Society for Mechanical Engineers in 1926. Mr. Newcomb was active in civic affairs

CHARLES L. NEWCOMB

of Holyoke and was identified with many corporations as an officer and member of the board. Funeral services were held March 15 at Holyoke Mass.

Twin City Group Elects New Officers

Twin City Foundrymen's association held its annual meeting recently. The major part of the evening was devoted to the election of officers who include William J. Snyker, St. Paul Foundry Co., St. Paul, president; Fred Christensen, R. R. Howell & Co., Minneapolis, vice president and C. E. Langdon secretary-treasurer. Members of the executive committee are S. V. Wood, Minneapolis Electric Steel Castings Co., Minneapolis, chairman; Carl Lagerquist, Lagerquist & Sons, Minneapolis; R. D. Bonneau, Commutator Co., Minneapolis; H. J. Kaim, Union Brass & Metal Mfg. Co., St. Paul; S. L. Cameron, Valley Iron Works, St. Paul and N. B. Craig, American Hoist & Derrick Co., St. Paul. Following

the election, Prof. H. S. Alexander, Macalester college, St. Paul gave an interesting lecture in which he discussed the various soils, clays and sands found in the Black Hills district of the Dakotas.

A. F. Preuster, for the past 10 years with the Republic Carbon Co., Niagara Falls, N. Y., has become connected with the International Graphite & Electrode Corp., Niagara Falls.

Equipment Orders Rise

The index for gross orders for foundry equipment in February was 196.4 as compared with 160.1 in January, according to a recent report of the Foundry Equipment Manufacturers' association. The index of shipments for February was 169.6 compared with 223.6 for January. Unfilled orders for February were 424.7 against 395.6 for January. The base is the average monthly shipments for the years 1922-23-24. Comparison by monthly orders as presented by the Foundry Equipment Manufacturers' association follow:

Month	1927	1928	1929	1930
Jan.	180.4	132.7	180.5	160.1
Feb.	198.0	123.6	197.0	196.4
March	131.1	138.6	209.4	.....
April	130.0	107.7	172.6	.....
May	134.8	335.6	177.7	.....
June	138.4	149.1	177.3	.....
July	89.9	94.8	219.3	.....
Aug.	106.4	278.0	229.5	.....
Sept.	80.4	170.0	216.3	.....
Oct.	98.0	185.0	245.3	.....
Nov.	95.8	197.8	178.6	.....
Dec.	106.8	166.5	208.0	.....

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Soultz Brass Foundry, Marion, Ind., recently has placed a new unit in operation.

Warner Brass Foundry, Algonac, Mich., suffered a slight damage by fire recently.

James B. Clow & Sons, Newcomerstown, O., is enlarging its plant. Its size will be almost doubled.

New Haven Foundry, New Haven, Mich., will build an addition to its foundry which will cost $12,000 and will increase the plant capacity about 10 per cent.

H. V. Dockray Brass & Iron Co., Zanesville, O., has changed its name to the Wise Foundry, Machine & Supply Co. Louis H. Wise is president and general manager.

Burgess Parr Co., Fifty-second street and Third avenue, Moline, Ill., is erecting a cement block building as a pattern and flask storage department.

South Park Foundry & Machine Co., South St. Paul, Minn., has consolidated its sales and factory offices into one main office at 818 North Concord street.

Merger negotiations have been opened between the Kalamazoo Stove Co., Kalamazoo, Mich., and the Brown Fence & Wire Co., Cleveland.

Ludin & May Foundry Co., 454 West Fifth street, Salt Lake City, Utah, has been issued a permit for the erection of a 2-story, 40 x 50 foot, machine shop addition.

Quality Aluminum Casting Co., Waukesha, Wis., recently has completed the installation of heat treatment equipment for aluminum castings. The company also recently completed an addition to its foundry.

Robert Mitchell Co., Ltd., Montreal, Que., operating a brass foundry, 750 Belair street, having recently completed a plant addition, will start work at once on alterations and addition to plant here. (Noted Nov. 15.)

Virginia Holding Co., Charles M. Walker, Royster building, Norfolk, Va., holding company representing undisclosed interests, has plans for a pipe foundry with a yearly capacity of 150,000 tons.

Damascus Steel Castings Co., Summer street, Hammond, Ind., formerly a subsidiary of the Damascus Steel Co., New Brighton, Pa., will be placed in operation after about a year's idleness by a group of Milwaukee financiers headed by B. A. Zikmund. About $200,000 will be spent on enlargement and rehabilitation.

Locomotive Finished Material Co., Atchison, Kans., is constructing a new steel foundry, 135 x 400 feet, and will install a 2½ ton electric furnace and other equipment for the production of steel castings. The company expects to have the new building ready for production about May 1. H. E. Muchnic is president and general manager and A. H. Morrhead is general superintendent.

Atchison Specialty & Mfg. Co., Atchison, Kans., is constructing a new brick building, 105 x 300 feet, to be used as a foundry and machine shop. The foundry is being equipped for the production of gray iron, brass and aluminum castings. George E. Cooke is president of the company and Charles Cooper is works manager.

New Trade Publications

RIDDLES—Buffalo Wire Works, 308-32 Terrace, Buffalo, has published a folder describing and illustrating the riddles it makes.

WELDING RODS — Fusion Welding Corp., 103rd and Torrence avenues, Chicago, has issued a folder which gives general information on the welding rods that it manufactures.

VIBRATORS — Malleable Iron Fittings Co., Branford, Conn., has issued a series of folders that explain the dimensions, details of construction, prices, etc., of the vibrators that the company makes.

PYROMETER EQUIPMENT—Leeds & Northrup Co., Philadelphia, recently has published three bulletins relating to galvanometers, electrical carbon dioxide recorders and temperature control methods for the nitriding of steel.

TRAMRAILS—Cleveland Electric Tramrail division of the Cleveland Crane & Engineering Co., Wickliffe, O., has published a folder on the many uses of its tramrails in the foundry industry. Several views of typical installations are shown.

AIR COMPRESSORS—General Electric Co., Schenectady, N. Y., in a recent folder describes its single stage, centrifugal air compressors for cupola blowing.

BUILDINGS—Frank D. Chase, Inc., 720 North Michigan avenue, Chicago, has issued a booklet entitled "The Service of the Archineer." The booklet gives the services made available for the customer and includes a list of some of the clients that the company has served.

GAS PUMPS—P. H. & F. M. Roots Co., Connersville, Ind., has issued two folders describing the advantages and illustrating the features and construction of its heavy and standard duty, roller-bearing, gas pumps. The bulletins feature a half-section view of the machines giving the advantages and details of construction.

CONVEYORS—Anchor Steel & Engineering Co., Detroit, has issued a pamphlet describing and illustrating the uses of the overhead conveyors that it manufactures. The information contained in the booklet includes the solution of a typical overhead conveyor problem, conveyor system layout, table showing chain pull, conveyor drives, data for curves, care and adjustment of units and description of the various parts used in the construction of an overhead conveyor.

ARC WELDERS—General Electric Co., Schenectady, N. Y., has issued three folders describing the distinctive features and the specifications for its belt or motor driven, stationary or portable, self-excited, variable-voltage, single operator machines and its belt, motor or gas engine driven, stationary or portable, self-excited, variable-voltage single operator machines. The first has a rating of 400 amperes, 25 volts, 1 hour, 50 degrees Cent. The others are rated at 200 amperes, 25 volts, 1 hour, 50 degrees Cent. and 300 amperes 25 volts, 1 hour, 50 degrees Cent.

SAND MIXERS—Royer Foundry & Machine Co., Wilkes-Barre, Pa., describes and illustrates the types of sand separators and blenders it manufactures in a current bulletin. The first portion of the bulletin is devoted to an explanation of the construction and operation of that machine and to a sketch showing the features and details of construction. The remainder of the publication contains halftone reproductions of the different type machines that the company manufactures together with the capacity in pounds of sand per minute, motor specifications, dimensions, weight of the machine.

SANDBLASTS—New Haven Sand Blast Co., New Haven, Conn., recently issued a 16-page catalog of the sandblast equipment that it manufactures. The booklet contains illustrations of the different types of installations and describes the advantages of each and the conditions most suited for their use. Line drawings that show the standard method of construction and explain the principles of ventilation of the different type rooms are included. Drawings are accompanied by tables that give the various dimensions according to the size of room to be installed.